



URBAN GreenUP

D6.6: RUPs delivered to the 4 follower cities

WP 6, T6.4

September 30, 2021

September, 2021 (M52)



Authors: RMI, MAN, LUD, MED, BIN, CAR

URBAN GreenUP

SCC-02-2016-2017

Innovation Action – GRANT AGREEMENT No. 730426

Technical References

| | |
|---------------------|--|
| Project Acronym | URBAN GreenUP |
| Project Title | New Strategy for Re-Naturing Cities through Nature-Based Solutions – URBAN GreenUP |
| Project Coordinator | Raúl Sánchez Fundación CARTIF rausan@cartif.es |
| Project Duration | 1 June 2017 – 31 May 2022 (60 Months) |

| | |
|--------------------------------|--|
| Deliverable No. | D6.6 |
| Dissemination Level | PU |
| Work Package | WP6 - REPLICATION AND CITY CLUSTERING |
| Task | T6.4 - Development of an implementation/replicability plan in each front-runner/follower city according to the project methodology |
| Lead beneficiary | 1 (RMI) |
| Contributing beneficiary (ies) | CAR, VAL, CHD, LIV, CFT, IZM, DEM, EGE, IZT, RMI, SPI, MAN, LUD, MED, BIN, CHE |
| Due date of deliverable | 31 May 2021 |
| Actual submission date | 30 Sep 2021 |



Copyright notices

©2019 URBAN GreenUP Consortium Partners. All rights reserved. URBAN GreenUP is a HORIZON2020 Project supported by the European Commission under contract No. 730426. For more information on the project, its partners and contributors, please see the URBAN GreenUP website (www.urbangreenup.eu). You are permitted to copy and distribute verbatim copies of this document, containing this copyright notice, but modifying this document is not allowed. All contents are reserved by default and may not be disclosed to third parties without the written consent of the URBAN GreenUP partners, except as mandated by the European Commission contract, for reviewing and dissemination purposes. All trademarks and other rights on third party products mentioned in this document are acknowledged and owned by the respective holders. The information contained in this document represents the views of URBAN GreenUP members as of the date they are published. The URBAN GreenUP consortium does not guarantee that any information contained herein is error-free, or up-to-date, nor makes warranties, express, implied, or statutory, by publishing this document.



Versions

| Version | Person | Partner | Date |
|-----------|-------------------------------|---------|---------------------------------|
| 0.1 | Charlotte Klose | LUD | 19 th May 2020 |
| 0.2 | Laura Gabriele | LUD | 10 th June 2020 |
| 0.3 | Alisa Krumm | LUD | 6 th October 2020 |
| 0.4 | Amely Krafft | LUD | 21 th January 2021 |
| 0.5 | Svenja Streicher | LUD | 10 th February 2021 |
| 0.6 | Amely Krafft | LUD | 23 th July 2021 |
| 0.1 | Tuan Nguyen | BIN | 10 th July 2021 |
| 0.2 | Cuong Nguyen | BIN | 20 th July 2021 |
| 0.3 | Trinh Tran | RMI | 2 nd August 2021 |
| 0.4 | Robert McClelland | RMI | 6 th August 2021 |
| 0.5 | Trinh Tran | RMI | 14 th September 2021 |
| 0.6 | Thami Croeser | RMI | 15 th September 2021 |
| 0.7 | Cuong Nguyen | BIN | 16 th September 2021 |
| 0.8 | Thami Croeser | RMI | 17 th September 2021 |
| 1 (FINAL) | Raúl Sanchez, Raquel Marijuan | CAR | 29 th September 2021 |



Table of Content

| | | |
|-------|---|----|
| 0 | Abstract..... | 20 |
| 1 | Introduction | 21 |
| 2 | Ludwigsburg RUP | 22 |
| 2.1 | Introduction..... | 22 |
| 2.1.1 | Overview of Ludwigsburg's challenges | 22 |
| 2.1.2 | Main challenges..... | 23 |
| 2.1.3 | How we developed this plan..... | 43 |
| 2.2 | Target | 44 |
| 2.2.1 | Targets for the RUP..... | 44 |
| 2.2.2 | Existing targets | 45 |
| 2.2.3 | How this RUP can be helpful..... | 46 |
| 2.3 | Adopted Solutions and Expected Impact | 48 |
| 2.3.1 | Focus districts for this RUP | 48 |
| 2.3.2 | Solutions..... | 48 |
| 2.4 | Legal barriers and other constraints..... | 56 |
| 2.4.1 | Assessment of the situation | 56 |
| 2.4.2 | Proposed initiatives | 57 |
| 2.5 | Programme and Budget | 59 |
| 2.6 | Stakeholders (roles and responsibilities) | 60 |
| 2.6.1 | Additional Institutions with a role in NBS..... | 60 |
| 2.6.2 | The implementing departments..... | 62 |
| 2.7 | Monitoring and reviewing | 64 |
| 2.8 | Integration..... | 66 |
| 2.9 | Revision of RUP | 67 |
| | Sources..... | 68 |
| 3 | Mantova RUP | 69 |
| 3.1 | Abstract | 69 |
| 3.2 | Introduction..... | 71 |
| 3.2.1 | Why we are making this plan | 71 |
| 3.2.2 | Overview of key stakeholders and co-creation approach | 75 |
| 3.3 | Key challenges in Mantova | 80 |
| 3.3.1 | Hot Summers and Heat Waves..... | 80 |
| 3.3.2 | Water management and flood risk | 83 |



| | | |
|---------|--|-----|
| 3.3.3 | Air quality..... | 87 |
| 3.4 | Targets | 89 |
| 3.4.1 | Targets for Mantova | 89 |
| 3.4.2 | Existing achievements..... | 89 |
| 3.4.3 | Existing Policy and activities | 95 |
| 3.5 | NBS Actions | 98 |
| 3.5.1 | Direct actions..... | 98 |
| 3.5.2 | Regulatory changes to promote NBS..... | 104 |
| 3.6 | Roles and responsibilities..... | 106 |
| 3.6.1 | Organization | 106 |
| 3.6.2 | Local communication and dissemination..... | 106 |
| 3.6.3 | The role of stakeholders in the development of next General Urban Plan | 108 |
| 3.7 | Processes and Reforms | 109 |
| 3.7.1 | Accessing Finance | 109 |
| 3.7.2 | Accessing land for NBS..... | 110 |
| 3.7.3 | Heritage restrictions..... | 110 |
| 3.7.4 | Aligning our organisation to deliver new NBS | 111 |
| 3.7.5 | The public procurement processes | 111 |
| 3.7.6 | Monitoring program and action plan..... | 112 |
| 3.7.7 | Baseline data..... | 113 |
| 3.7.8 | KPI..... | 113 |
| 3.7.9 | Review and adaptive management process | 113 |
| 4 | Medellin RUP | 115 |
| 4.1 | Abstract | 115 |
| 4.2 | Introduction..... | 115 |
| 4.2.1 | Green Management: Medellín's Progress..... | 117 |
| 4.2.1.1 | <i>A Multiscalar Planning Approach</i> | 118 |
| 4.2.2 | Relationships of The City's Plans and The URBAN GreenUP Project | 121 |
| 4.2.3 | Municipal Development Plan 2016 - 2019 " <i>Medellín Counts on You</i> " | 122 |
| 4.2.4 | Development plan 2020 – 2023 " <i>Medellín futuro</i> " | 126 |
| 4.2.5 | How we made this plan | 127 |
| 4.3 | Analysis of key challenges | 129 |
| 4.3.1 | Evaluation of co-benefits of the challenges of URBAN GreenUP | 129 |
| 4.3.2 | Criteria for the prioritization of challenges in the city of Medellín | 141 |
| 4.3.3 | Identification of the Territorial Offer in the City of Medellín | 142 |
| 4.4 | Regulatory context..... | 146 |
| 4.4.1 | National Policy Framework..... | 146 |
| 4.4.2 | Identification of Standards Related to the Renaturalization of Medellín | 147 |



| | | |
|--------|--|-----|
| 4.5 | Guidelines for governance, institutional articulation and landscape management for the renaturalization of Medellín..... | 150 |
| 4.5.1 | Outcomes of the internal workshop with officials of the Mayor's Office of Medellín 151 | |
| 4.5.2 | Guidelines for intra-institutional articulation | 156 |
| 4.5.3 | Identification of Relevant and Priority Projects..... | 157 |
| 4.6 | NBS for Medellín | 160 |
| 4.6.1 | Existing NBS..... | 160 |
| 4.6.2 | Nature-based Solutions - NBS and categories | 165 |
| 4.6.3 | Conceptual model for future NBS selection | 166 |
| 4.6.4 | NBS Prioritized | 167 |
| 4.7 | Territorial prioritization model for the application on NBS..... | 170 |
| 4.7.1 | Analysis of challenges, city problems..... | 172 |
| 4.7.2 | Information for the representation of challenges and <i>subretos</i> in Medellín | 174 |
| 4.7.3 | Spatialization of Challenges and <i>Subretos</i> in Medellín | 186 |
| 4.7.4 | Structure for the classification of the territorial offer | 192 |
| 4.7.5 | Intersection of challenges and territorial offers | 200 |
| 4.8 | Spatial planning case study: Ecological Connectivity | 202 |
| 4.8.1 | Pilot Project for the Ecological Connectivity of the Urban Green Corridors of the City of Medellín..... | 202 |
| 4.9 | Management model: roles and responsibilities for delivery | 214 |
| 4.9.1 | Management Model for the Implementation of the Medellín Renaturalization Plan 215 | |
| 4.9.2 | Key Actors | 217 |
| 4.10 | Co-creation | 219 |
| 4.10.1 | Participation in the URBAN GreenUP project | 219 |
| 4.10.2 | Workshops..... | 220 |
| 4.10.3 | Actions and projects in the territories | 222 |
| 4.11 | Financial strategy | 224 |
| 4.11.1 | Objectives of the financial strategy..... | 225 |
| 4.11.2 | Methodological route | 225 |
| 4.11.3 | Selection of instruments and consolidation of the financial strategy..... | 226 |
| 4.11.4 | Guidelines for the implementation of the financial strategy..... | 232 |
| 4.12 | Landscape planning and management guidelines..... | 233 |
| 4.12.1 | Guidelines for generation | 233 |
| 4.12.2 | Guidelines for maintenance..... | 234 |
| 4.12.3 | Guidelines for planning..... | 234 |
| 4.13 | Integration: how we will deliver the RUP | 235 |
| 4.13.1 | Demonstration of the Proposed Methodology..... | 238 |



| | | |
|-------|---|-----|
| 4.14 | Monitoring and follow-up system..... | 242 |
| 5 | Quy Nhon RUP | 244 |
| 5.0 | Abstract | 244 |
| 5.1 | Introduction..... | 245 |
| 5.1.1 | Quy Nhon city landscape and development..... | 245 |
| 5.1.2 | The natural conditions, landscape and ecosystem | 248 |
| 5.1.3 | Summaries on the spatial planning of Quy Nhon city | 251 |
| 5.2 | The city's current challenges existing NBS and its targets related to NBS implementation..... | 253 |
| 5.2.1 | The city's current challenges..... | 253 |
| 5.2.2 | City's existing and activities towards NBS application | 260 |
| 5.2.3 | The city's NBS implementation targets and stakeholders..... | 262 |
| 5.3 | Objectives and scope of the Renature Urban Plan for Quy Nhon | 265 |
| 5.3.1 | Objective..... | 265 |
| 5.3.2 | Scope of this RUP | 265 |
| 5.3.3 | Zoning of Quy Nhon urban area for RUP implementation | 266 |
| 5.4 | NBS selection for RUP | 268 |
| 5.4.1 | Characteristics and the challenges of each zone..... | 268 |
| 5.4.2 | Summary | 273 |
| 5.5 | The RUP implementation role and responsibility | 280 |
| 5.5.1 | Implementation principle..... | 280 |
| 5.5.2 | Role and responsibility of each party | 280 |
| 5.6 | Piloting NBS in Quy Nhon RUP..... | 282 |
| 5.6.1 | Piloting the green facades for Zone 1 – Inner city of Quy Nhon – N1..... | 282 |
| 5.6.2 | Piloting the wastewater treatment – electrowetland at Ha Thanh river and Thi Nai lagoon Zone (N2) | 283 |
| 5.6.3 | Piloting the raingarden in Nhon Hoi economic zone (N3) | 284 |
| 5.7 | Management, implementation, revision and development of Quy Nhon RUP..... | 285 |
| 5.7.1 | Management and implementing RUP | 285 |
| 5.7.2 | RUP updating and revision..... | 285 |
| 5.7.3 | RUP promotion | 286 |
| | References..... | 287 |
| 6 | Annexes..... | 288 |
| | Annex 1: Evaluation of all regulatory instruments pertaining to NBS in Medellín | 288 |
| 6.1.1 | Regulations within the Mayor's Office of Medellín..... | 288 |
| 6.1.2 | Description key..... | 318 |
| 6.1.2 | Regulation at the regional scale (Corantiquoia) | 325 |
| | Annex 2: Stakeholder workshop proposals for improvements to NBS delivery. | 326 |



Appendix 3: Interview and details of the successful 30 Green Corridors Project..... 328

Annex 4: Distribution of neighbourhood ranges for each commune 342

Annex 5: Analysis of benefits and scale of NBS in the GreenUP NBS Catalogue..... 355

 6.5.1 Potential NBS application scales 358

 6.5.2 Potential Contributions of NBS to Ecosystem Services and Territorial Supply 359

Annex 6: Analysis of key stakeholders and potential roles. 372

Annex 7: Financial analysis 392

 6.7.1 Evaluation of instruments..... 393

Annex 8 - 30 GREEN CORRIDORS..... 407



List of Tables

| | |
|---|-----|
| Table 2.1: Summary of planned measures..... | 59 |
| Table 2.2: Table of stakeholders in the co-creating of the plan | 62 |
| Table 2.3: Table of the stakeholders in the implementation of the plan | 63 |
| Table 2.4: Overview of challenges and measurability..... | 64 |
| Table 3.1: Identification of the main actors..... | 78 |
| Table 3.2: Review and adaptative management process | 114 |
| Table 4.1: Challenges addressed by this RUP..... | 117 |
| Table 4.2: Evaluation of co-benefits of the challenges of URBAN GreenUP..... | 130 |
| Table 4.3: Identification and classification of the territorial offer for Medellín. Source: own elaboration 2019..... | 143 |
| Table 4.4: Green infrastructure on urban land | 144 |
| Table 4.5: Blue infrastructure on urban land | 145 |
| Table 4.6: Grey infrastructure on urban land | 145 |
| Table 4.7: Actors involved in the management of green infrastructure and ecological structure, based on the regulatory review carried out. | 151 |
| Table 4.8: Number of Trees Planted in the Intervened Corridors Identified in 2018..... | 162 |
| Table 4.9: Identification of the sites where the green walls have been installed in Medellín as of 2019..... | 164 |
| Table 4.10: List of gardens installed by commune (m ²) to 2019. Source: Ministry of Environment of Medellín (2019)..... | 164 |
| Table 4.11: Prioritized typologies of NBS..... | 169 |
| Table 4.12: Challenges and sub-challenges (<i>subretos</i>) considered in the Territorial Prioritisation Model | 174 |
| Table 4.13: Definition of ranges for the average sum of over position of <i>subretos</i> for communes of Medellín | 187 |
| Table 4.14: Presence of each <i>subretos</i> in communes being 0 the lowest value and 1 the highest | 190 |
| Table 4.15: Definition of ranges for the average sum of over position of <i>subretos</i> for neighborhoods of Medellín..... | 191 |
| Table 4.16: Hierarchal structure for the classification of green, blue and grey infrastructure. | 194 |
| Table 4.17: Green Infrastructure Classification..... | 196 |



| | |
|--|-----|
| Table 4.18: Cartography related to the classification of Green infrastructure..... | 196 |
| Table 4.19: Blue Infrastructure Classification | 197 |
| Table 4.20: Cartography related to the classification of blue infrastructure..... | 197 |
| Table 4.21: Classification of grey infrastructure | 199 |
| Table 4.22: Cartography related to the classification of grey infrastructure..... | 199 |
| Table 4.23: Leaders of the environmental tables for workshop 1..... | 221 |
| Table 4.24: Summary table of the participatory process..... | 221 |
| Table 4.25: Average ranges of over-position of sub-challenges in communes in relation to the early actions carried out by the municipal administration | 238 |
| Table 4.26: Prioritized indicators for NBS monitoring in Medellín | 243 |
| Table 5.1: Description of the three proposed zones for NBS implementation..... | 276 |
| Table 6.1: Tree species planted in Avenida Oriental corridor..... | 331 |
| Table 6.2: “Minor species” planted in Avenida Oriental corridor..... | 332 |
| Table 6.3: Progress of each corridor located in ravines..... | 333 |
| Table 6.4: Progress of each corridor located on tracks..... | 333 |
| Table 6.5: Approximate area of each corridor located in ravines..... | 334 |
| Table 6.6: Approximate area of each corridor located on tracks | 335 |
| Table 6.7: Hard areas converted to green areas..... | 336 |
| Table 6.8: Average and over-position ranges of challenges and <i>subretos</i> for neighbourhoods of Medellín | 342 |
| Table 6.9: Average of prom range and <i>subretos</i> | 354 |
| Table 6.10: Early actions or NBS prior to the URBAN GreenUP project..... | 358 |
| Table 6.11: Potential scales for NBS application..... | 358 |
| Table 6.12: Potential contributions of NBS to Ecosystem Services and Territorial Supply..... | 370 |
| Table 6.13: Instances identified with relevance for the formulation of the Renaturalization Plan | 389 |
| Table 6.14: Proposal of Actors, Roles and Functions for the implementation of the Medellín Renaturalization Plan | 391 |
| Table 6.15: Inventory of instruments for the financing (generation, maintenance and qualification) of green spaces | 393 |
| Table 6.16: Meetings held for the financial strategy | 394 |



List of Figures

| | |
|---|----|
| Figure 2.1: Increase in the average median temperature in Baden-Württemberg, Source: LUBW 2020..... | 23 |
| Figure 2.2: Rise in the number of hot days in Baden-Württemberg (median values of climate modelling), Source: LUBW 2020..... | 24 |
| Figure 2.3: Projected temperature rise, Source: LUBW 2020..... | 24 |
| Figure 2.4: General city map of Ludwigsburg, Source: www.ludwigsburg.de | 25 |
| Figure 2.5: Urban climate analysis for Ludwigsburg, Source: City of Ludwigsburg | 26 |
| Figure 2.6: Urban climate analysis: IPCC Scenario 8.5 for 2030, Source: City of Ludwigsburg... | 26 |
| Figure 2.7: Total precipitation (in the winter month) total in Baden-Württemberg, Source: Klimaatlas Baden-Württemberg, 2020..... | 27 |
| Figure 2.8: Total precipitation total in Baden-Württemberg (summer), Source: Klimaatlas Baden-Württemberg, 2020 | 28 |
| Figure 2.9: Measuring Stations in Ludwigsburg, Source: Google Maps/City of Ludwigsburg | 29 |
| Figure 2.10: Days with exceedances of the legal limit concerning PM10..... | 29 |
| Figure 2.11: Annual mean value concerning exceedances of NO2 limits | 30 |
| Figure 2.12: Map of noise in and around Ludwigsburg in 2017, Source LUBW | 30 |
| Figure 2.13: Overview plans of Ludwigsburg | 31 |
| Figure 2.14: The FEK of Ludwigsburg with the Green-Ring, Source: Feasibility study Landesgartenschau | 34 |
| Figure 2.15: Riverside Meadows Ludwigsburg from above, Source: City of Ludwigsburg | 35 |
| Figure 2.16: Shallow Bank at Riverside Meadows Ludwigsburg, Source: City of Ludwigsburg .. | 36 |
| Figure 2.17: Bridge for pedestrians at Riverside Meadows Ludwigsburg..... | 36 |
| Figure 2.18: Historical record and current situation | 37 |
| Figure 2.19: Green Room Ludwigsburg..... | 38 |
| Figure 2.20: The mobile Green Room makes a stop in Ludwigsburg, Source: City of Ludwigsburg | 38 |
| Figure 2.21: Example for green companies, Source: City of Ludwigsburg..... | 38 |
| Figure 2.22: The car park before and after greening | 39 |
| Figure 2.23: On the left, a parklet in an industrial area; on the right, greenery at a bus stop ... | 39 |
| Figure 2.24: Green roof on a municipal building | 40 |



| | |
|---|----|
| Figure 2.25: Organization Chart of Ludwigsburg, Source: City of Ludwigsburg..... | 41 |
| Figure 2.26: Important tasks and stakeholders..... | 42 |
| Figure 2.27: Focus districts in the city of Ludwigsburg | 48 |
| Figure 2.28: left: Heat stress in the city centre; right: Drawing of the Green Court of Honour; Source: City of Ludwigsburg..... | 49 |
| Figure 2.29: Current parking situation in the Ehrenhof; Source: City of Ludwigsburg | 50 |
| Figure 2.30: Pictures of the temporary measures in the Court of Honor; Source: City of Ludwigsburg | 50 |
| Figure 2.31: Idea of the 1st prize winner MANN LANDSCHAFTSARCHITEKTUR, FULDA..... | 51 |
| Figure 2.32: Images from the feasibility study for the State Garden Show..... | 52 |
| Figure 2.33: Example of GREEN AWNINGS from Valladolid; Source: https://www.urbangreenup.eu/news--events/news/municipal-plan-to-install-green-awnings-this-year-with-1-5-million-investment.kl | 52 |
| Figure 2.34: Example of movable trees Source: http://www.wanderbaumallee-stuttgart.de/ | 53 |
| Figure 2.35: Example of the green noise barrier..... | 53 |
| Figure 2.36: Technical drawing of the noise barrier | 54 |
| Figure 2.37: Current situation on the Neckar | 55 |
| Figure 2.38: Sketch for the redesign | 55 |
| Figure 2.39: Possible tree locations | 55 |
| Figure 2.40: Steps of implementation..... | 66 |
| Figure 3.1: The River Po Valley, bordered by the Alps (north) and the Apennines (south), shapes Mantova's climate..... | 71 |
| Figure 3.2: Newspapers' photo of extreme storms | 72 |
| Figure 3.3: Lakes surround Mantova on three sides..... | 72 |
| Figure 3.4: Site of National Interest (SIN) | 73 |
| Figure 3.5: Opportunities and risks to using wood for domestic heating..... | 75 |
| Figure 3.6: Photographs from local stakeholders meetings | 76 |
| Figure 3.7: Stakeholders map..... | 77 |
| Figure 3.8: Cold days (%) in Mantova..... | 80 |
| Figure 3.9: Hot days (%) in Mantova | 81 |
| Figure 3.10: Humidex index in Municipality of Mantova | 81 |
| Figure 3.11: Vulnerability complex map | 82 |



| | |
|--|-----|
| Figure 3.12: Vulnerability on heat waves..... | 83 |
| Figure 3.13: Scheme of Mincio Basin | 84 |
| Figure 3.14: R95p - total amount of daily rainfall above 95th percentile during the year, expressed in millimetres; R50 - number of days in the year with precipitation of at least 50mm; RX1DAY - maximum daily precipitation; RX5DAY - maximum precipitation in 5 days. | 85 |
| Figure 3.15: Run-off with 20 mm rain | 86 |
| Figure 3.16: Run-off with 60 mm rain | 86 |
| Figure 3.17: Run-off with 110 mm rain | 87 |
| Figure 3.18: PM10 in 2018 in Mantova Province | 88 |
| Figure 3.19: The PAESC of Mantova..... | 96 |
| Figure 3.20: Localization of Nature-based Solutions in Mantova | 99 |
| Figure 3.21: Proposal for Piazzale Montelungo | 103 |
| Figure 3.22: View of the current situation of Via Tasso..... | 104 |
| Figure 3.23: Diagram of the roles and responsibilities organization | 106 |
| Figure 3.24: Photo by Openfabric during FAO Event in 2018 | 107 |
| Figure 3.25: Participation of Mantova City Council in URBACT C-Change | 107 |
| Figure 4.1: Roles of this RUP | 116 |
| Figure 4.2: URBAN GreenUP challenges applicable to Medellín and its relationship with the categories of analysis (green, blue, grey infrastructure and social actions)..... | 117 |
| Figure 4.3: Management of urban greening considers the full project cycle at multiple scales | 119 |
| Figure 4.4: Multiscalar scheme for urban green analysis | 119 |
| Figure 4.5: Definition of scales considered in the RUP. | 120 |
| Figure 4.6: Relationship Municipal Development Plan (2019-2019) and (2020 – 2023) and Green Up Urban Project in the management of the green of Medellín | 122 |
| Figure 4.7: Pedestrian green corridor. Paseo Bolívar..... | 122 |
| Figure 4.8: Plans under the municipal plan could interface with URBAN GreenUP | 124 |
| Figure 4.9: Strategic projects under the municipal development plan | 126 |
| Figure 4.10: Phases of the RUP development..... | 127 |
| Figure 4.11: Medellín RUP schedule and activities | 128 |
| Figure 4.12: Relationships between challenges in URBAN GreenUP..... | 131 |



| | |
|--|-----|
| Figure 4.13: Co-benefits among the challenges, with <i>Reto 1</i> (Challenge 1 - Climate Change) clearly playing an ‘umbrella’ role | 131 |
| Figure 4.14: Co-benefits curve for challenge 1 | 133 |
| Figure 4.15: Co-benefits curve for challenge 2 | 134 |
| Figure 4.16: Co-benefits curve for challenge 3 | 135 |
| Figure 4.17: Co-benefits curve for challenge 4 | 136 |
| Figure 4.18: Co-benefits curve for challenge 5 | 136 |
| Figure 4.19: Co-benefits curve for challenge 6 | 137 |
| Figure 4.20: Co-benefits curve for challenge 7 | 139 |
| Figure 4.21: Co-benefits curve for challenge 8 | 140 |
| Figure 4.22: Co-benefits curve for challenge 9 | 140 |
| Figure 4.23: Classification of challenges in the prioritisation process | 141 |
| Figure 4.24: Mapping of infrastructure types | 143 |
| Figure 4.25: Graph of the distribution of territorial supply in urban land – Medellín | 144 |
| Figure 4.26: List of National Policies and Local Norms Identified as Relevant to the Strategy and the Renaturalization Plan for Medellín | 147 |
| Figure 4.27: Relative weight of the main functions and competences of all the Secretariats involved in the management of the green infrastructure and the ecological structure of Medellín. | 152 |
| Figure 4.28: Local and Regional Planning Instruments Related to a Renaturalization Strategy for Medellín | 158 |
| Figure 4.29: Number of convergent projects with a Renaturalization Plan in the main territorial and sectoral planning instruments of Medellín and the Aburrá Valley | 159 |
| Figure 4.30: Urban Green Corridors in Medellín..... | 161 |
| Figure 4.31: Example of a green wall in Medellín | 163 |
| Figure 4.32: Green walls in Medellín..... | 164 |
| Figure 4.33: Communes with gardens installed as of 2019 | 165 |
| Figure 4.34: Model proposed for NBS selection to support formulation of the Medellín RUP | 166 |
| Figure 4.35: Document structure of the Territorial Model for the Medellín Renaturalization Plan..... | 170 |
| Figure 4.36: Conceptual structure of the Territorial Model for the Medellín Renaturalization Plan..... | 171 |
| Figure 4.37: Synthesis Challenge 1, adaptation and mitigation to climate change | 174 |



| | |
|--|-----|
| Figure 4.38: Synthesis Challenge 2, water management | 176 |
| Figure 4.39: Synthesis Challenge 3, Green and blue space management | 177 |
| Figure 4.40: Synthesis Challenge 4, Air Quality..... | 179 |
| Figure 4.41: Synthesis Challenge 5: Sustainable Urban Development | 180 |
| Figure 4.42: Synthesis Challenge 6, participatory planning and governance | 181 |
| Figure 4.43: Justice and Social Cohesion..... | 183 |
| Figure 4.44: Synthesis Challenge 8, welfare and public health..... | 184 |
| Figure 4.45: Spatialization of challenges diagram..... | 186 |
| Figure 4.46: <i>Subretos</i> diagram | 186 |
| Figure 4.47: Percentage of communes according to ranges of the average of the sum of overlapping <i>subretos</i> | 187 |
| Figure 4.48: Average ranges of over position of <i>subretos</i> for the communes of Medellín | 188 |
| Figure 4.49: Percentage of neighborhoods according to ranges of the average sum of overlapping <i>subretos</i> , with rank ranging from 1 (low) to 3 (high). | 191 |
| Figure 4.50: Average ranges of over position of <i>subretos</i> for the neighbourhoods of Medellín. | 192 |
| Figure 4.51: Conceptual scheme to structure the territorial offer of the Medellín Renaturalization Plan | 193 |
| Figure 4.52: Definition of priority polygon and inventory of green areas | 204 |
| Figure 4.53: Existing green areas within the priority polygon | 204 |
| Figure 4.54: Selected bird species..... | 205 |
| Figure 4.55: Species of mammals selected | 206 |
| Figure 4.56: Procedure performed to obtain the resistance matrices | 207 |
| Figure 4.57: Probability of occurrence matrix and resistance matrix for the Real Tanager <i>cyanicollis</i> , one of the species analysed..... | 207 |
| Figure 4.58: Nodes and perimeter points to estimate connectivity paths | 208 |
| Figure 4.59: Connectivity model for each metho..... | 209 |
| Figure 4.60: Final model of functional ecological connectivity with the theoretical elements that make up the network within the polygon | 209 |
| Figure 4.61: Classification of the delimited green areas according to the FINAL model of functional ecological connectivity..... | 210 |
| Figure 4.62: Priority areas for the management of the functional ecological connectivity network..... | 211 |



| | |
|---|-----|
| Figure 4.63: Grouping of Landscape Units in Functional Landscape Areas | 212 |
| Figure 4.64: Naming and defining landscape areas, such as Landscape Districts..... | 212 |
| Figure 4.65: Intervention Areas and Landscape Strategies for the Design District | 213 |
| Figure 4.66: Fields of Analysis for the Construction of a Management Model for the Medellín Renaturalization Plan | 214 |
| Figure 4.67: Administrative Structure Municipality of Medellín..... | 216 |
| Figure 4.68: Proposal of the Undersecretariat of Green Infrastructure and Ecological Structure for the Implementation of the Renaturalization Plan for Medellín..... | 217 |
| Figure 4.69: Workshops invitations..... | 222 |
| Figure 4.70: Photos of community projects in commune 1..... | 222 |
| Figure 4.71: Photos of community projects carried out in commune 1 | 222 |
| Figure 4.72: Photos of community projects in commune 6..... | 223 |
| Figure 4.73: Methodological scheme..... | 226 |
| Figure 4.74: RUP institutional management model..... | 236 |
| Figure 4.75: NBS classification into 13 categories..... | 236 |
| Figure 4.76: Superposition of the challenges of the municipal polygon..... | 237 |
| Figure 4.77: Prioritized neighbourhoods for the implementation of NBS..... | 237 |
| Figure 4.78: Case studies of the application of the proposed methodology | 241 |
| Figure 5.1: Overview of the city in 1932 | 245 |
| Figure 5.2: Quy Nhon city in 1969..... | 245 |
| Figure 5.3: Urban planning for Quy Nhon in 2004 | 246 |
| Figure 5.4: Revision of Quy Nhon urban planning towards 2020 | 246 |
| Figure 5.5: View of the current coastline of Quy Nhon city..... | 247 |
| Figure 5.6: Green space in the public park next to the shoreline highly valued for the landscape of the city | 247 |
| Figure 5.7: The revised urban planning of Quy Nhon and its vicinity to 2035 and vision to 2050 | 247 |
| Figure 5.8: The mangrove wetland ecosystem and the sandune topographical landscape of Phuong Mai peninsula part of the city is under pressure from urban development | 248 |
| Figure 5.9: Quy Nhon city topography | 249 |
| Figure 5.10: The division of the river basin where Quy Nhon city is inside (red circle)..... | 249 |
| Figure 5.11: Mangrove forest “green lung” of the city..... | 249 |



| | |
|--|-----|
| Figure 5.12: Hinh. Dong Da ecological lake | 249 |
| Figure 5.13: The structure of Quy Nhon population over the years | 250 |
| Figure 5.14: Population growth of Quy Nhon over the years | 250 |
| Figure 5.15: The linear increasing trend of annual average temperature measured at Quy Nhon (°C) period 1961 - 2019 | 253 |
| Figure 5.16: The increasing trend of the maximum temperature in Quy Nhon period 1961 - 2019..... | 254 |
| Figure 5.17: The increasing trend of minimum temperature period 1961 - 2019..... | 254 |
| Figure 5.18: Temperature scenarios (annual average temperature) at Quy Nhon according to RCP4.5 (left) and RCP8.5 (right) | 254 |
| Figure 5.19: Change in the green area (which is replaced by urban area, infrastructure, landuse change) from 2009 - 2019 (Google Earth)..... | 255 |
| Figure 5.20: Annual rainfall trend at Quy Nhon period 1961 - 2019 | 256 |
| Figure 5.21: One day and five day maximum rainfall at Quy Nhon, period 1961 - 2019..... | 256 |
| Figure 5.22: River system around Quy Nhon city and the flood map of Quy Nhon | 257 |
| Figure 5.23: The damage caused by Hurricane Matmo (2019)..... | 258 |
| Figure 5.24: The flooding of the road system in 2020 | 258 |
| Figure 5.25: Air quality monitoring locations..... | 258 |
| Figure 5.26: TSP concentration measured in the residential areas (QCVN: 0.3 mg/m ³) | 258 |
| Figure 5.27: Monitored noise parameter (dBA) in residential area..... | 259 |
| Figure 5.28: Air quality monitoring locations in the industrial areas of Quy Nhon city..... | 259 |
| Figure 5.29: TSP concentration measured in the industrial areas (QCVN: 0.3 mg/m ³) | 259 |
| Figure 5.30: Water quality monitoring locations | 260 |
| Figure 5.31: Measured BOD ₅ in the water body on Ha Thanh river and Thi Nai lagoon | 260 |
| Figure 5.32: Part of the green space in Quy Nhon city and Quy Nhon is honored with Clean Tourism Award 2020 | 260 |
| Figure 5.33: The development of mangrove forest at Thi Nai lagoon 2012 and 2019 | 261 |
| Figure 5.34: Green landscape development with tourism activities on Phuong Mai peninsula | 261 |
| Figure 5.35: Planting new tree in the one billion trees national campaign | 261 |
| Figure 5.36: View of Dong Da lake after the renovation..... | 262 |
| Figure 5.37: Campaign on cleaning up the beaches (2019) | 262 |



| | |
|---|-----|
| Figure 5.38: Public artwork on solid waste and plastic waste collection on Quy Nhon beach (2020) | 262 |
| Figure 5.39: Steps implemented in the development of Quy Nhon renaturing urban plan..... | 266 |
| Figure 5.40: Zonning of Quy Nhon city for the RUP plan and the application of NBS | 266 |
| Figure 5.41: Sand moving in the Nhon Hoi economic zone | 272 |
| Figure 5.42: Selected NBS applied in zone N1 | 277 |
| Figure 5.43: Selected NBS applied in zone N2 | 278 |
| Figure 5.44: Selected NBS applied in zone N3 | 279 |
| Figure 5.45: Summary of the arrangement between agencies related to NBS at Quy Nhon city | 280 |
| Figure 5.46: Green façade solution at the Dong Da intersection of Quy Nhon | 282 |
| Figure 5.47: Electro wetland application at Ha Thanh river and Thi Nai area (N2) | 283 |
| Figure 5.48: Rain garden on the median strip of Nhon Hoi economic zone traffic route..... | 284 |
| Figure 6.1: San Juan Corridor. Before the green corridor. It shows an urban corridor area that will be intervened as a green corridor. | 337 |
| Figure 6.2: San Juan Corridor. After the green corridor. Decreases in radiant heat between 6°C and 8°C are shown at noon. | 337 |
| Figure 6.3: Argentine Corridor. | 337 |
| Figure 6.4: Oriental Avenue Corridor with intersection with Caracas Street | 338 |
| Figure 6.5: Oriental Avenue Corridor with junction with the bridge between San Juan and Los Huesos..... | 338 |
| Figure 6.6: Main regulatory and support Ecosystem Services | 371 |
| Figure 6.7: Main provision Ecosystem Services | 371 |
| Figure 6.8: Main cultural Ecosystem Services | 371 |



0 Abstract

The aim of this report is to provide global view of the replicability actions of the Project, specifically focussed on the Renaturing Urban Plans (RUPs) generated in the project for and by Follower Cities (FW Cities). The deliverable is related to Task 6.4 about the development of the implementation and replicability plan in each Front Runner and Follower City, taking into account the project methodology.

The document explains the process of RUPs development in each Follower City and how these cities are adopting the URBAN GreenUP.

The report integrates in a document the main aspects of the RUPs implementation in Follower Cities, such as the overview of FW Cities challenges, their policy context, a review of existing NBS in FW Cities, the main and existing targets and a technical final reflexion on how the RUP could be helpful to Cities in their renaturing processes.

Follower Cities have also identified the main stakeholders involved in the RUP creation and implementation. Finally, FW Cities make a description of NBS adopted from Front Runners Cities as solutions for their challenges.



1 Introduction

This report contains the basis of the ‘Renaturing Urban Plan’ (RUP) developed by each follower city: Ludwigsburg, Mantova, Medellin and Quy Nhon.

The methodology and tools as the ‘NBS Catalogue’ carried out in the URBAN GreenUP project have served as the basis for developing and defining replicability plans in FW Cities, with the aim of to mitigate the effects of climate change, improve air quality and water management, and increase cities sustainability through NBS.

Each city has developed their own RUP according their inherent characteristics, including relevant information regarding the following themes:

- The main environmental challenges each city is facing with regard to Climate Change adaptation;
- Targets of the RUP and how it is helpful to address these challenges;
- NBS actions implemented in the city and their expected impacts;
- Necessary steps for RUPs implementation, including barriers encountered to overcome in the NBS implementation;
- Identification of institutions and stakeholders involved with a role in NBS development, their roles and responsibilities;
- Monitoring of the indicators selected for each challenge identified at first;
- How each city is going to manage, revision and develop their RUP

Once the RUP is defined, it is expected to be implemented and performed in each follower city.



2 Ludwigsburg RUP

2.1 Introduction

2.1.1 Overview of Ludwigsburg's challenges

The City of Ludwigsburg is facing a range of challenges as our climate changes.

It is expected more heatwaves and droughts as well as heavy rainfall events, in which the appearance of large amounts of rain accumulating in a short time are increasing.

Besides heatwaves and cloudbursts, other extreme weather events are also associated with climate change. Over the last 20 years, violent winter storms and hail events have also occurred more and more frequently in Ludwigsburg, although this trend will continue as our climate changes¹.

These climatic effects in Ludwigsburg are already noticeable and it is forecasted that these effects will get more significant in the future. The heatwaves in summer times for example reduce citizen wellbeing and work performance. Vector-borne diseases as well as allergies will occur more frequently. In relation to agriculture, increased soil erosion may be a consequence of heavy rain events. Especially in winter months, an increase in flooding is expected. Flood risk is particularly high near the Neckar river. Flooded basements for example have been a problem for private households as well as companies.

Climate change is not the only challenge – Ludwigsburg also must reduce air pollution and noise. Much of this is caused by traffic. Accordingly, the development of mobility alternatives will be a major challenge in the future. With cycling as one of the central elements of future mobility, the need for more cycle paths is growing. Meeting existing demand is challenging, but we consider it important that even more people should be encouraged to use the bicycle, especially for short distances.

These main challenges are described in more detail and with data in the following section.

¹Klik 2016: 18



2.1.2 Main challenges

2.1.2.1 Increasing Temperature

The region around Ludwigsburg is with an average annual temperature of 12°C one of the warmest areas in Germany. The results of the robust climate model indicate that temperature will increase about 2,5°C in Ludwigsburg until the end of the 21st century. In the whole state of Baden-Württemberg an increase of 3 °C is forecasted. ²

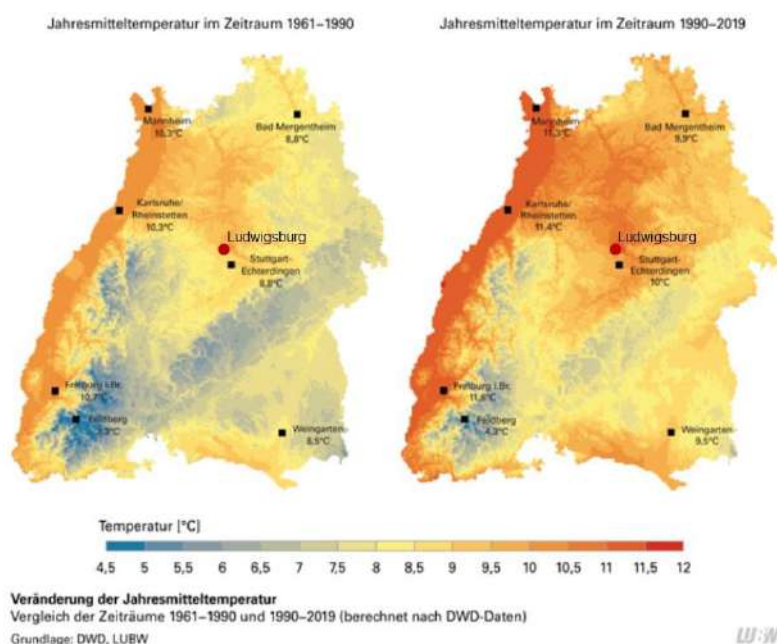


Figure 2.1: Increase in the average median temperature in Baden-Württemberg, Source: LUBW 2020

Although the result of the climate model shows some variances, it's very likely that the number of hot days will increase. At the end of the last century there were about eight days where the temperature exceeded 30°C. According to climate forecasting, it is anticipated around 30 hot days a year until by 2100.

² KliK 2016: 14

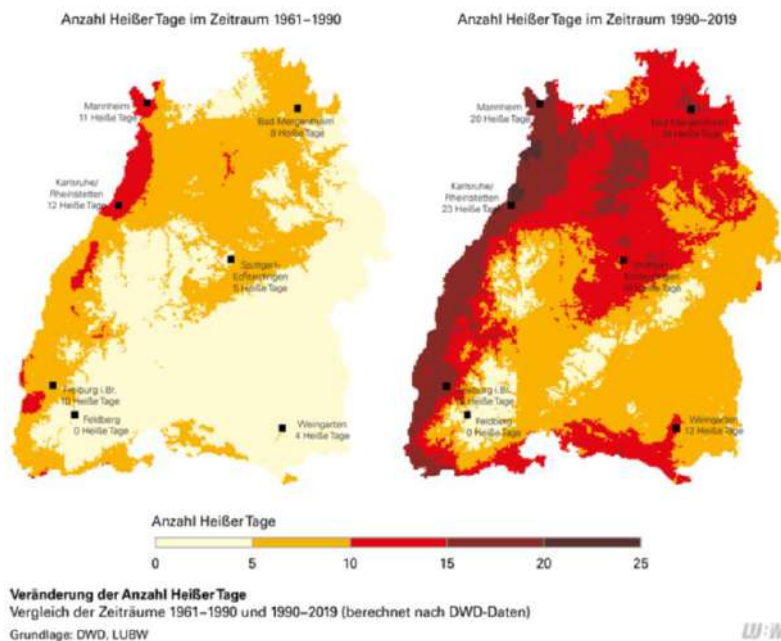


Figure 2.2: Rise in the number of hot days in Baden-Württemberg (median values of climate modelling), Source: LUBW 2020

Tropical nights, in which temperature does not drop below 20°C, are fairly rare in Ludwigsburg. Corresponding to the increase in the number of hot days, Ludwigsburg can expect to get more tropical nights as well. At this time there is not a clear forecast yet.



Figure 2.3: Projected temperature rise, Source: LUBW 2020

These changes will have a major impact on life in Ludwigsburg. According to a vulnerability analysis, the most significant effects of climate change on the people in the region are the increase in heat exhaustion and in deaths from extreme heat events.

But urban ecosystems and plants will also suffer from climate change. Severe heat and drought will severely endanger urban trees and it will be a challenge to preserve them. Green spaces will dry out and lose their cooling function.

Heat Island effect in Urban Areas

The high density of buildings in urban areas often contributes to an increase in temperatures compared to the surrounding countryside. This phenomenon is known as the “heat island effect” and with regard to climate change it is going to increase. Therefore, the development of green infrastructure is necessary (see KliK 2016: 20, 46, 99).

It is of great importance to visualize the urban climate data to have an overview of the areas of a city which are overheated during summer high-pressure weather conditions and which areas have a compensatory cooling effect. In order to show this, an urban climate analysis was carried out for the city of Ludwigsburg in a 25x25m grid, shown in Figure 2.5 and Figure 2.6. It is regarded as an important basis for planning and includes meteorological parameters as well as an evaluation of the individual areas.

To provide a better overview of the districts of Ludwigsburg, a general city map is shown first.

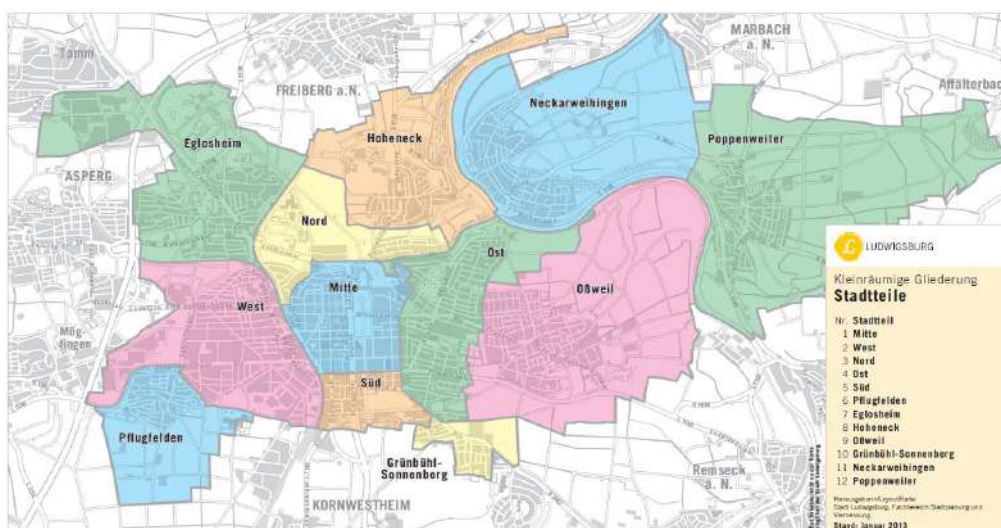


Figure 2.4: General city map of Ludwigsburg, Source: www.ludwigsburg.de

Figure 2.5 shows the current urban climate in Ludwigsburg.

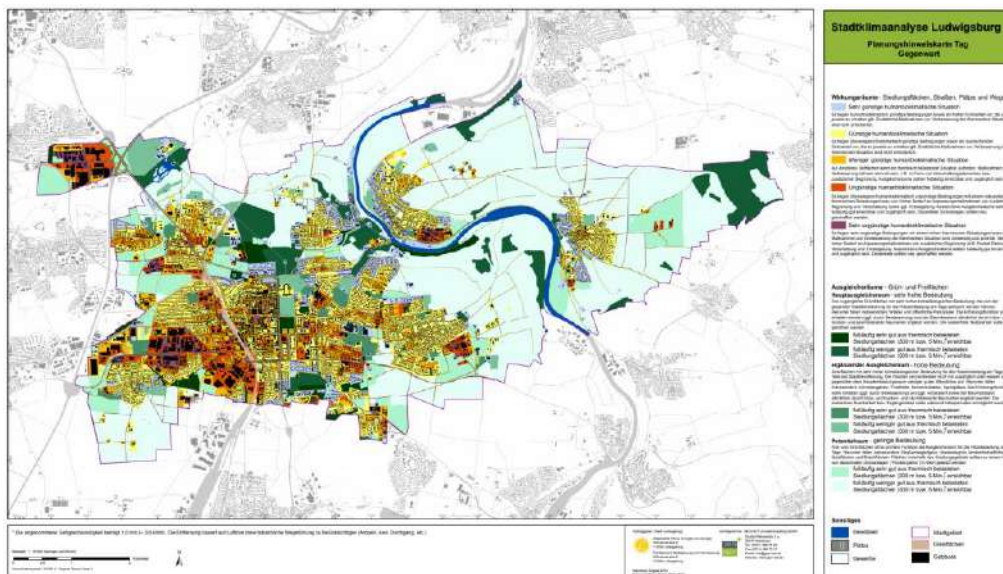


Figure 2.5: Urban climate analysis for Ludwigsburg, Source: City of Ludwigsburg

The legend on the right shows a colour scale that defines the gradations. Blue areas mean that the human bioclimatic conditions at the respective location are very good. Purple areas, on the other hand, indicate very unfavourable conditions.

To map the urban climate in Ludwigsburg in 2030, the modelling was carried out with temperatures increased by IPCC scenarios 8.5 and 2.3, and potential new construction areas were taken into account.

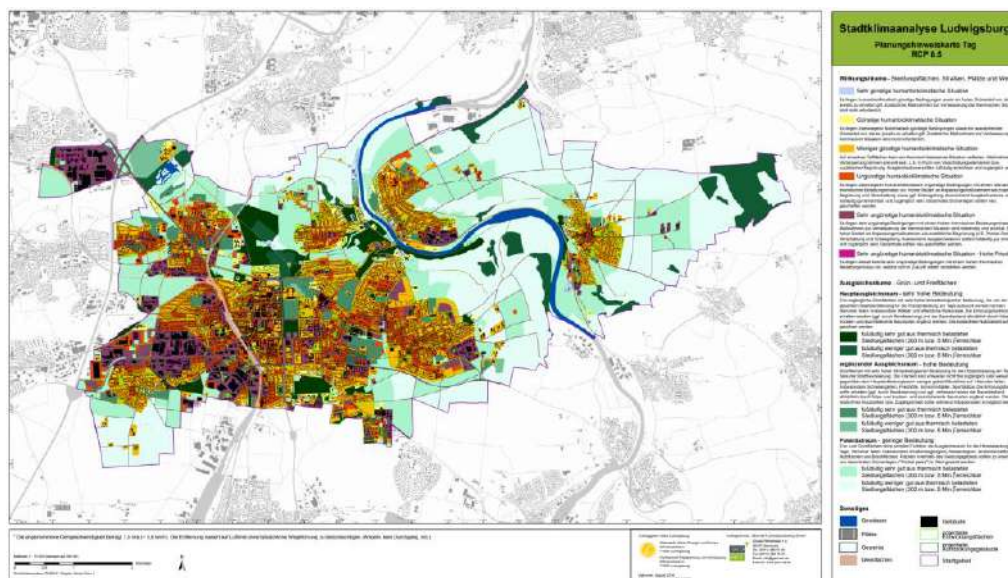


Figure 2.6: Urban climate analysis: IPCC Scenario 8.5 for 2030, Source: City of Ludwigsburg

Here again blue areas mean that the human bioclimatic conditions at the respective location are very good. Pink and purple areas, on the other hand, indicate very unfavourable conditions.

It is evident that the situation in the already burdened areas of the inner city and the industrial areas will worsen considerably. But also, the first residential areas, such as in the district of Oßweil, will already have very unfavourable human bioclimatic conditions

This can be illustrated by the example of the city centre. It is characterised by a baroque perimeter block development with tiled inner courtyards. Green structures with an impact on the climate are hardly present here and the public space also has a high degree of sealing. This predominance of unshaded material means these urban areas absorb a lot of heat.

2.1.2.2 Rainfall, drainage and water management

Ludwigsburg is located in Baden-Württemberg in one of the areas with low precipitation due to the location between the Black Forest and the Swabian Alb. The median annual precipitation total is about 700 l/m² compared to the regional median of 990 l/m² (see Kliik 2016:17; see Verbandregion Stuttgart 2008).

According to current research, the median precipitation total is not about to change. However, there are two trends observable. On the one hand a seasonal redistribution of the precipitation total, which means a decrease in precipitation in the summer half-year, i.e. drier summers. In the winter months higher precipitation levels are to be expected. As it also becomes warmer, the rainfall increases while it snows less at the same time. And on the other hand, more frequent heavy rainfall events.

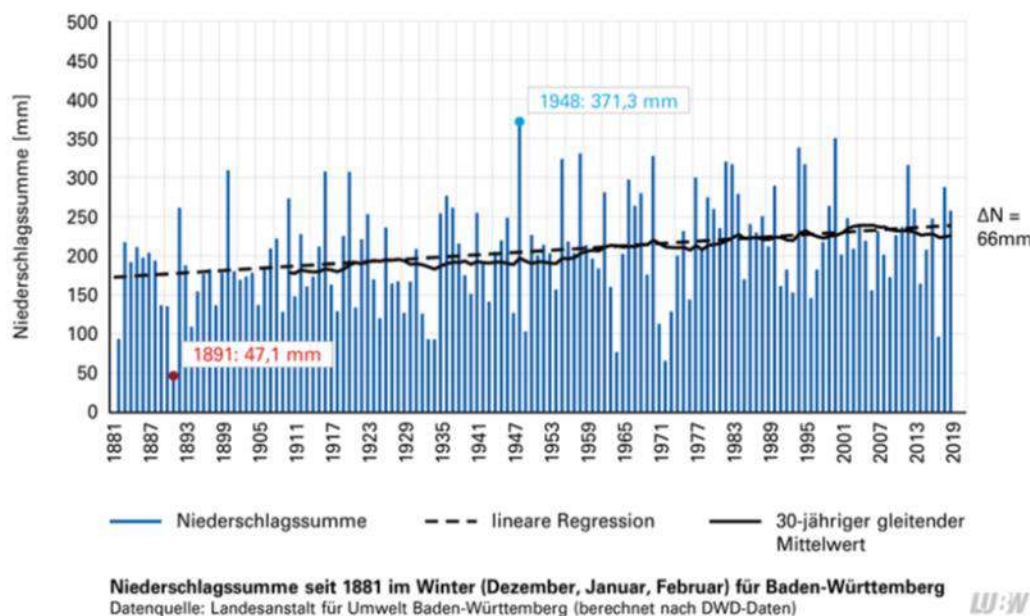


Figure 2.7: Total precipitation (in the winter month) total in Baden-Württemberg, Source: Klimaatlas Baden-Württemberg, 2020

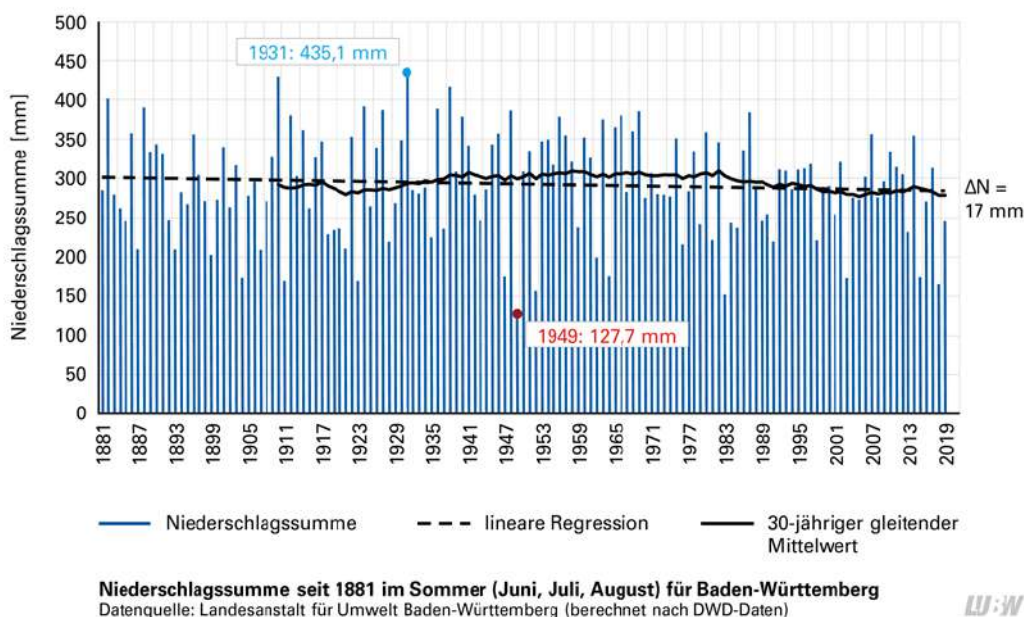


Figure 2.8: Total precipitation total in Baden-Württemberg (summer), Source: Klima atlas Baden-Württemberg, 2020

At the moment, most excess storm water flows into sewage systems. However, the sewage system is constructed for a 3 – 5 year heavy rain event; as heavy rainfall in winter becomes more frequent, we can expect more flooding. The current aim of Ludwigsburg’s sewage drainage system is to drain the excess rain storm water as fast and harmlessly as possible. As the risk of flooding increases, it will be important to intercept storm water using Nature-based Solutions. With good design, we can keep and use the rain water, potentially as a supply for later watering of green areas.

2.1.2.3 Air quality and noise

The overall poor ventilation situation in Ludwigsburg is problematic in view of the high air pollution³.

The quality of air in Ludwigsburg, specifically the concentration of PM10 and NO₂, is monitored constantly at two measuring stations of the state’s air-monitoring network. The main measuring station is located in Friedrichstraße and a second measuring station is located in Weimarstraße. At these measuring stations monitoring of NO₂, PM2,5, PM10 and O₃ takes place⁴.

³ see Klik 2016:18

⁴ see LUBW

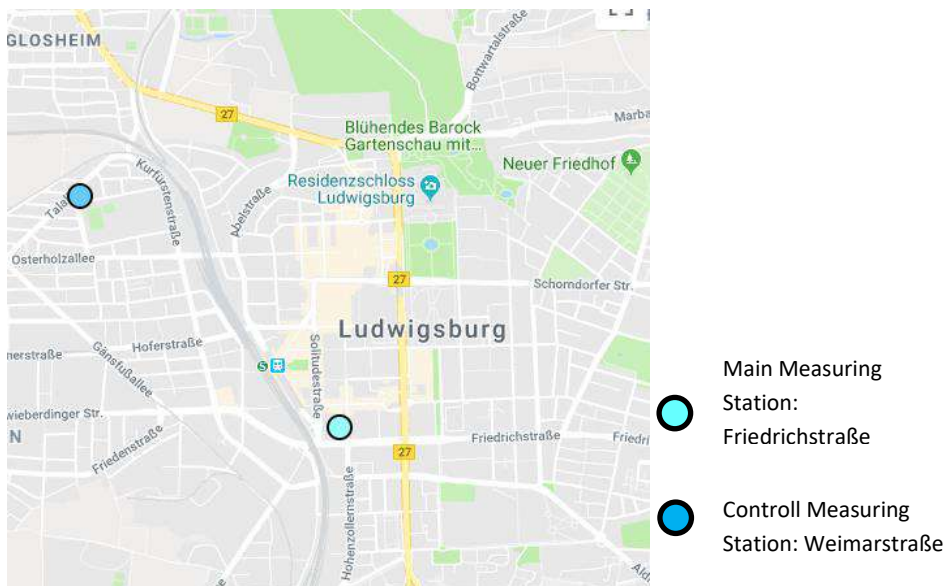


Figure 2.9: Measuring Stations in Ludwigsburg, Source: Google Maps/City of Ludwigsburg

The annual assessment for 2019 showed that in Ludwigsburg the admissible daily mean value for concentration of fine particles ($50 \mu\text{g}/\text{m}^3$) was exceeded on 11 days (35 days are maximum permissible according to EU regulatory limits) at the measuring station, located on a major traffic arterial, called Friedrichstraße (also see chart below). However, compared with other measuring spots the annual mean value of $23 \mu\text{g}/\text{m}^3$ did not by far reach the maximum permissible value of $40 \mu\text{g}/\text{m}^3$.

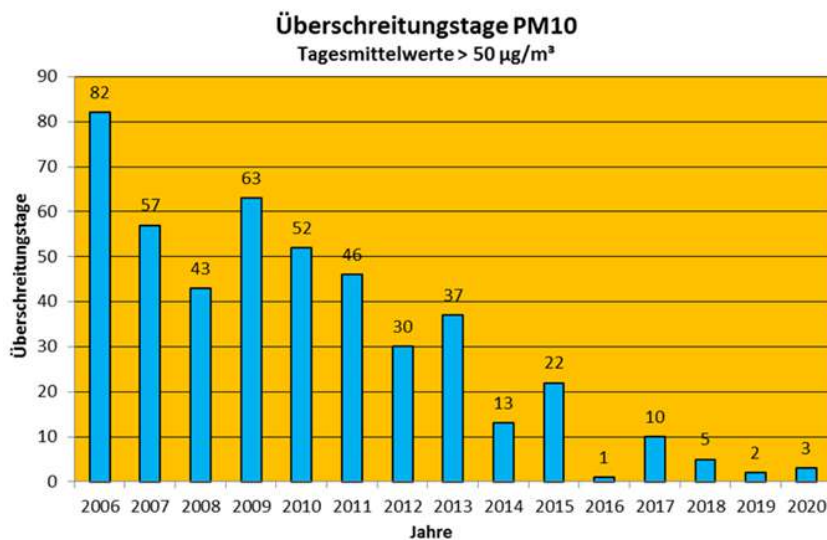


Figure 2.10: Days with exceedances of the legal limit concerning PM10⁵

Concerning the concentration of nitrogen dioxide (NO_2) the annual mean value for Ludwigsburg is problematic. With $58 \mu\text{g}/\text{m}^3$ the admissible limit value of $40 \mu\text{g}/\text{m}^3$ was

⁵ <https://www.lubw.badenwuerttemberg.de/luft/grenzwertueberschreitungen/vorjahr>
<https://www.lubw.baden-wuerttemberg.de/luft/jahreswerte+>

exceeded again in 2015 (see chart below). Nevertheless, the data shows a constant improvement, mainly due to the introduction of the environmental zone in 2008 banning high-emission vehicles from driving through the city.

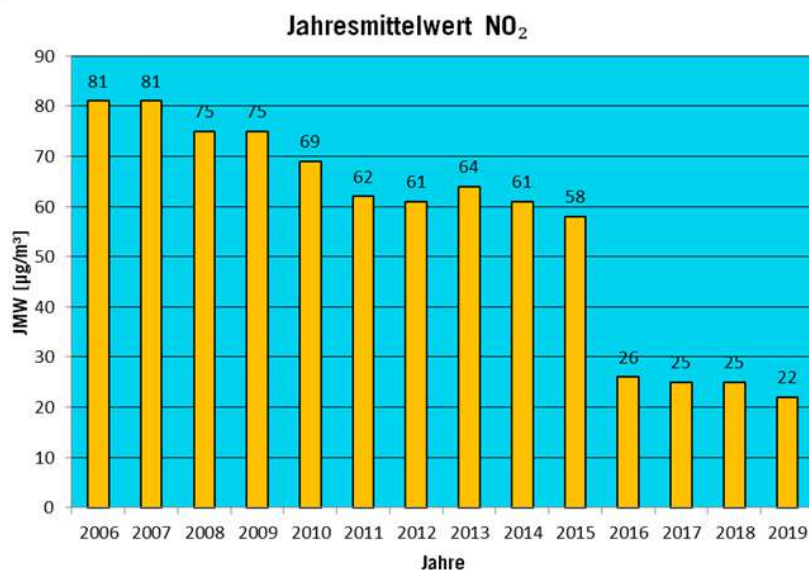


Figure 2.11: Annual mean value concerning exceedances of NO₂ limits⁶

Noise and acoustic environment

The graphic below shows a day-night-night noise map over 24 hours to assess the general noise pollution. It can be identified that the motorway 81 with a noise pollution of more than 75 dB(A) seems to be the biggest polluter. The federal highway B27, running directly to the city also causes a huge amount of noise pollution with about 55 to 70 dB(A). During the day, the limits for noise exposure are between 60-67 dB (A) and at night between 50-57 dB(A).

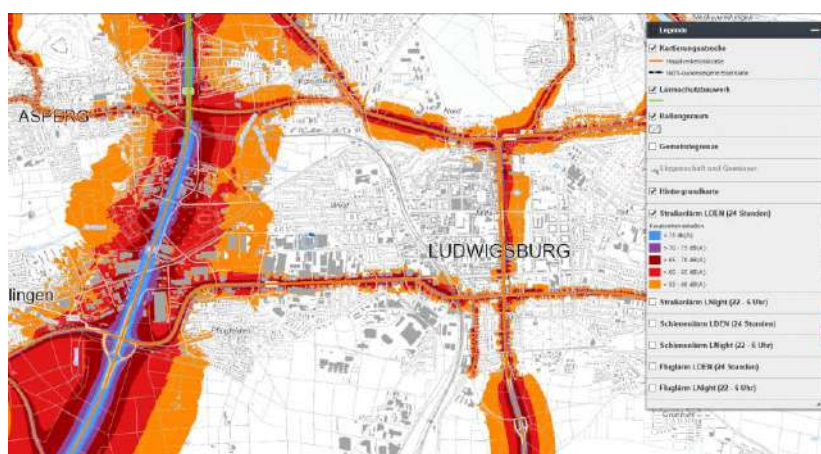


Figure 2.12: Map of noise in and around Ludwigsburg in 2017, Source LUBW

⁶ Source: <https://www.lubw.baden-wuerttemberg.de/luft/jahreswerte>
<https://www.lubw.baden-wuerttemberg.de/luft/grenzwertueberschreitungen/vorjahr>

As the map shows, there are several areas in Ludwigsburg that are strongly affected by noise. Creative new solutions must be found here to use NBS to provide protection against noise.

2.1.2.4 Policy context

Starting position:

The city of Ludwigsburg is guided by an overarching policy: The Urban Development Concept (SEK). Under this concept, there are three others that determine how the City of Ludwigsburg intends to act in a climate-protected and climate-adapted manner: the Climate Adaptation Concept (KliK), the Integrated Climate Protection and Energy Concept (iKEK) and the Strategic Concept for Open Space and Green Areas (FEK). Especially the KliK is regarded as an important basis for the development of NBS.

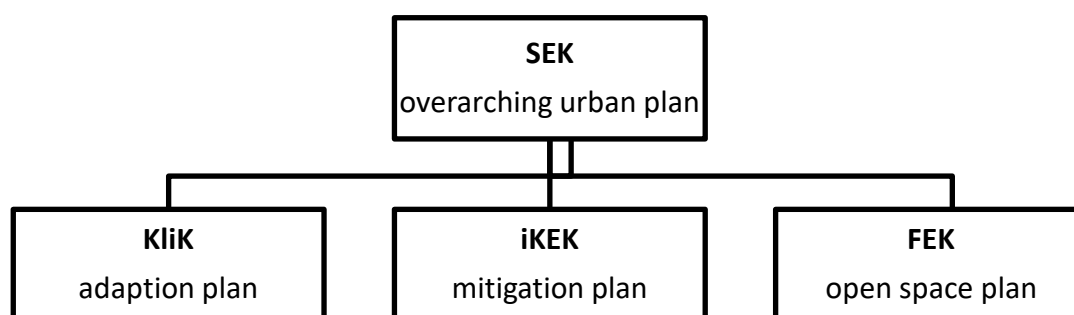


Figure 2.13: Overview plans of Ludwigsburg

Urban Development Concept (Stadtentwicklungskonzept, SEK)

Since the beginning of 2004, Ludwigsburg has been putting an Urban Development Concept into action under the slogan “Opportunities for Ludwigsburg”. The Ludwigsburg city council decided at a meeting on the 28th of June 2006 which principles and strategic objectives would govern the 11 thematic areas of the Urban Development Concept. These thematic areas included economy, employment, mobility and energy, amongst others.

Integrated Climate Protection and Energy Strategy (Integriertes Klimaschutz- und Energiekonzept Ludwigsburg, iKEK)

The integrated climate protection and energy concept (iKEK) of the City of Ludwigsburg developed in 2020 from the previous concept, named the overall energy concept (GEK). The aim of the GEK and iKEK is to achieve climate neutrality by 2050. With the updating of the former GEK, the effectiveness of the measures implemented to date was reviewed and new climate protection measures were developed on the basis of this. In addition, the city's targets up to 2050 were adjusted and tightened. The first steps in the iKEK were to prepare the starting point for the energy and greenhouse gas balance of the City of Ludwigsburg and to evaluate existing climate protection activities of the city administration. In parallel, GHG reduction potentials and scenarios for various consumption sectors were prepared. One scenario shows how energy consumption and emissions could develop if the current climate

policy framework is maintained. The other describes a way to achieve the goal of climate neutrality by 2050.

Climate adaptation concept (Klimaanpassungskonzept, KliK)

For cities and municipalities in Germany it is not only a social but also a legal obligation to reduce the negative effects of climate change on people, the economy and nature. The City of Ludwigsburg wants to fulfil this obligation and commissioned a concept for adapting to the consequences of climate change in 2015. The Climate Adaptation Concept (KliK) analysed the extent of progressive climate change in Ludwigsburg on the basis of existing scientific data. Subsequently, its possible effects on urban areas of action were identified. It was shown that the increase in heat in particular poses major challenges for the city.

Without adaptation measures, all areas, private, commercial and public sectors as well as nature will be severely affected. This requires the protection and development of urban green spaces and the sustainable promotion of the water cycle in the city. Furthermore, recommendations are given on how to strengthen climate adaptation in urban development planning in Ludwigsburg. A modular system was developed for the climate-adapted development of the neighbourhoods. It explains the most efficient measures, such as roof and façade greening or cooling oases. Measures are then proposed for each building. Public buildings primarily serve as role models. Finally, the urban structure types in Ludwigsburg that are most affected by climate change are identified. Based on exemplary selected quarters, packages of measures were proposed for the individual types. A plan for the climate adaptation concept presented the most important spatial measures.

The "most efficient" or "basic" measures are defined as those that can basically be used everywhere in the city and which having a positive effect on climate adaptation. They represent a kind of basic catalogue that every urban planner can use as a basis. No local conditions are taken into account here. The catalogue contains short- and medium-term measures that should be implemented primarily in heavily polluted areas. In principle, they can be implemented in any neighbourhood. The aim is to ensure that all important measures are taken into account in all planning. For example, when drawing up a building plan or in urban development competitions.

The "basic" measures are:

- Building greening (roof and façade greening)
- Shading / tree planting
- Green courtyards
- Cooling oases
- Unsealing
- Deconstruction of surplus buildings
- Light surface design / albedo
- Design with water
- Drinking water dispensers



These basic measures are supplemented in the concept by very different and creative measures. Some of these are very specific and related to the respective neighbourhood.

Ludwigsburg has defined specific measures for the inner courtyards in this part of the city, such as the preservation and planting of trees, the unsealing of areas, the deconstruction of buildings that are not worth preserving, the greening of buildings and the greening of facades. However, the measures must always be implemented with regard for the protection of the historical monuments which you can often find in this district. In the city's streets, shading can also be increased through the use of NBS.

Strategic Concept for Open Space and Green Areas (FEK)

The open space development concept forms a basis for the realisation of a double interior development (urban densification, while extension and preservation of green) in Ludwigsburg. Strategies and measures for the development and networking of green and open spaces, for maintaining and increasing the quality of a living environment and for structural densification and its conditions are worked out. The concept is not to be considered in isolation. It rather serves as a supplement to existing plans and concepts. The FEK should serve as a basis for future urban land use planning⁷.

The Green Ring is a sequence of very different green spaces. Gardens, parks, the river landscape of the Neckar and wooded and agricultural areas are connected by the "Green-Ring-Trail" and developed as local recreation areas for the people. The development and redesign of the green areas in the Green Ring and in the City Centre should be in the Residential areas and near workplaces special Places with great attraction and quality of stay to be developed.

The map shows where green spaces already exist in the city and where they do not. The dashed green line shows the green ring that is to be created in the long term. In this way, a continuous green circuit through the entire city area is created. The goal is also to better connect the different parts of the city with the help of the green ring.

⁷ see: FEK 2014: 7



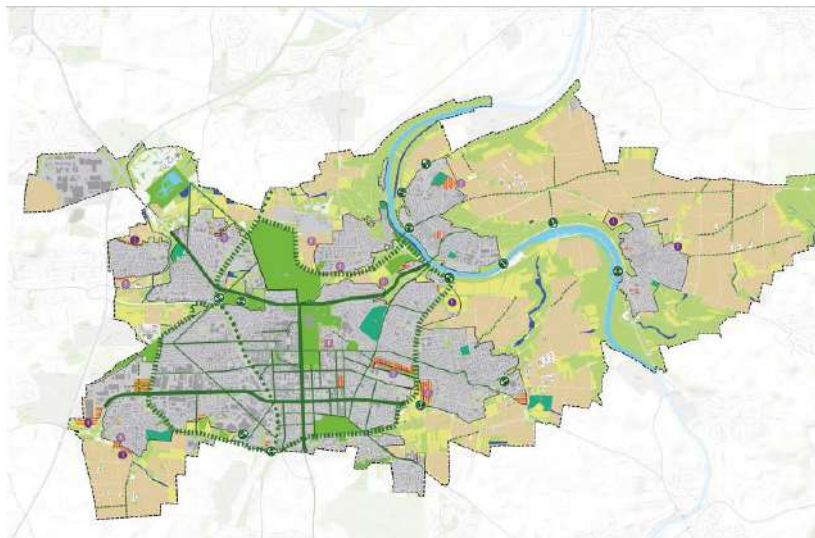


Figure 2.14: The FEK of Ludwigsburg with the Green-Ring, Source: Feasibility study Landesgartenschau

Strategic Concept for Open Space and Green Areas (Freiflächenentwicklungskonzept, FEK)

To ensure the linking of green spaces and ventilation, the FEK has been developed in 2014. The FEK delivers an analysis of the current state of open space and green areas development, recommending further measures for improvement.

The FEK sets following guidelines:

- dual development of the inner city (infill development and extension of green space)
- integration of FEK planning principles into the development plan
- use of FEK as informal, strategic planning tool, to be applied in urban land use planning, neighbourhood development and construction projects to ensure a climate resilient urban landscape

The main objectives on the level of operation are:

- the development of a continuous network with green shaded connections for pedestrians and cyclists. This “green ring” connects the districts of West, South, East and inner city on the border to the outdoor area of the city; e.g. the city concluded recently on a greening concept for the street Comburgstraße, providing the plantation of trees and the establishment of grass verges.
- the preservation and quality assurance of trees

2.1.2.5 Review of existing NBS in Ludwigsburg prior to the implementation of URBAN GreenUP

There are already a few existing NBS in Ludwigsburg:

- Riverside Meadows on the Neckar
- ‘Greenway Ludwigsburg’ trail along the Neckar
- The "Hungerberg" a habitat for wild bees
- Green rooms as shady oases

- Habitats on roofs
- Green company gardens
- Parking space transformation into green areas

Riverside Meadows:

Because the Neckar was first used for shipping, the steep riverside was concreted and paved. At that time, water ecology played hardly any role, which made it difficult for plants and animals to find a typical aquatic habitat.

When the bank reinforcement became in need of renovation at the beginning of the 2000s, nature-oriented ideas came up: A project partnership between the City of Ludwigsburg and the Water and Shipping Authority of Stuttgart made it possible to temporarily rehabilitate the bank both above and below water. It does justice to the aquatic ecology, also by creating spawning grounds and habitats for young fish. Jointly planned and executed, the result was an attractive, structurally rich and above all eventful riverside landscape. The new, extensive, shallow bank zones are well fortified under water. In combination with so-called Lahnungsbauwerke, which weaken the swell and protect the bays, optimal conditions have been created for new water-land habitats. The targeted planting of typical water trees and the use of native seeds are not only adapted to aquatic ecology - they also offer a visual attraction. Suitable bays are being made accessible to pedestrians: here they can linger, enjoy the view of the water or enjoy the cool waters of the Neckar barefoot.



Figure 2.15: Riverside Meadows Ludwigsburg from above, Source: City of Ludwigsburg



Figure 2.16: Shallow Bank at Riverside Meadows Ludwigsburg, Source: City of Ludwigsburg

Greenway Meadows

The city renatured the Neckar riverside “Zugwiesen” from 1998 to 2013. The project included the restoration of a natural riverine habitat, comprising 17 hectare and costed eight-million-euro. Hereby it was possible to replace the aquatic transportation route into a biotope with a lot of space for native flora and fauna. Also, the scenic beauty of the river at the foot of the striking steeps provides a local recreation area. The Zugwiesenbach connects the Neckar above and below the barrage Poppenweiler, so aquatic animals can use both areas as a habitat. Also, the amount of water bird species rose from formerly 4 to 18 in 2014 as well as the occurring plant species, which significantly multiplied from 213 species observed in 2007 to 396 in 2014.⁸



Figure 2.17: Bridge for pedestrians at Riverside Meadows Ludwigsburg

⁸ EGL 2018: 17 et seq.

“Hungerberg” & Casa Mellifera

The area of the "Hungerberg" quarry was initially a quarry, which was then converted into a habitat area in cooperation with the former owner. Today the area is a habitat for wild bees, turtles and yellow-bellied mites, for native fruit trees and bushes - and last but not least for the urban population.

The Casa Mellifera Natural InfoCentre in the green area of the Hungerbergs - the honeybee hive - with its clay walls and green roof is itself a biotope. The ice storage heating system makes it an energy lighthouse project in Ludwigsburg. The Casa was developed in cooperation with the Ludwigsburg Beekeepers' Association for the purpose of environmental education and beekeeper/beekeeper training.⁹



Figure 2.18: Historical record and current situation

Green Room

The "Green Room" was finished in April 2014 and is located in the Rathaushof. Its "living" walls and ceilings consist of around 7,000 perennials and 40 plane trees, which together make up about 140 m² of vegetation. The "Green Room" fulfils several functions: It invites you to linger because of its lush greenery and colourful flowers. The dense foliage protects visitors from street noise. And aromatic plants such as lavender, cloves, thyme and mint make the stay a sensory experience. The "Green Room" is also very valuable for the city climate as a small ecological niche. The water supply of the small inner-city oasis is sustainable: Its irrigation system is fed by three cisterns, which can store a total of six cubic metres of rainwater. In the summer of 2018 a "Mobile Green Room" was on tour in Ludwigsburg. On particularly hot public squares it served as a cooling oasis, with shade and colourful flowers.

⁹ City of Ludwigsburg: Casa Mellifera



Figure 2.19: Green Room Ludwigsburg



Figure 2.20: The mobile Green Room makes a stop in Ludwigsburg, Source: City of Ludwigsburg

Green Company Garden

Every green space is a benefit for people, plants and animals. But for companies that receive customers, a green environment is also a useful business attraction. In order to make the green side of companies aware of the public, the cooperation "Green Neighbourhood" invented the competition in the "Company Garden – Green and Good" in 2016. In total, 20 company owners applied with photos, a short text and site plan. A jury of experts and cooperation partners evaluated these 14 outdoor facilities according to design, ecological and social aspects as well as their functionality and identified the winning companies. On 4 December 2017, the Green Neighbourhood awarded the companies with the 4 winning outdoor facilities.



Figure 2.21: Example for green companies, Source: City of Ludwigsburg

Cooperation Company

The climate is changing, temperatures are rising and hot spells are becoming longer and more frequent. This is particularly noticeable in the city, where there is usually little cooling possible - so greenery in the city is becoming increasingly important. With the funding and research project "Urban Agenda - Green City", various approaches are currently being tested in the Groenerstrasse industrial estate in Ludwigsburg's Weststadt district to provide a remedy for this.

For example, the parking lot at the corner of Schlieffenstraße has been redesigned as a small park. Employees from neighbouring companies will be able to spend their breaks there, and benches will soon be added.

In Groenerstrasse, new break rooms have been set up: Instead of a parking bay, two "parklets" have been set up there over the summer. These "furnished parking spaces" are made of pallets. In addition, some greenery is included to provide more quality of stay. Climbing plants were also installed at two bus stops - another small contribution to climate-adapted urban design.



Figure 2.22: The car park before and after greening



Figure 2.23: On the left, a parklet in an industrial area; on the right, greenery at a bus stop

Green Roof



Figure 2.24: Green roof on a municipal building

The picture above shows the green roof of the building Karlstraße 21, which is placed between two schools and will soon in addition have a photovoltaic system.

Since July 2020, the implementation of a photovoltaic system is generally supposed to always be combined with a green roof. The combination is due to the fact, that photovoltaic system is more efficient with a green roof and is also more protected against wind and storm. Moreover, they can retain water from heavy rainfalls to relieve the sewage water system and offer a natural habitat for various plants and animals.

The NBS are good, but not sufficient

The measures described are all important in terms of climate change adaptation. Especially the large measures like the "Zugwiese" offer a high level of protection and a great added value for animals, plants and the citizens of Ludwigsburg. In the daily work, more and more NBS are being integrated into urban planning. This means that more and more green roofs and shady places will automatically be created in Ludwigsburg in the future. On the one hand, this is because existing plans and policies provide for it, but also because the planners are aware that NBS represents a great added value for the city in terms of climate adaptation and the value they add to the quality of the city. This is an important aspect, because it makes the implementation of NBS a matter of course in the long term. In addition to these classic NBS, which are anchored in the concepts and in everyday planning, Ludwigsburg needs even more solutions. These solutions must be specifically adapted to the city and be creative. They must be specifically geared to the city's goals and take local needs into account.

2.1.2.6 Institutional Settings for NBS

In order to plan and realise this RUP, different stakeholders are necessary. In Germany, there are quite clearly regulated procedures for construction measures. But beyond the prescribed processes, a lot of communication and coordination is needed within the city administration, because different departments have to work well together. One department alone cannot plan

and implement the measures. In addition, the funds must be made available by the municipal council. The most important stakeholders in relation to the NBS are briefly described below.

Organization chart

In Ludwigsburg there are three offices, which are mainly involved in planning, design, construction and maintenance of NBS. Those offices are Urban Planning; Civil Engineering & Green Spaces; Climate, Energy and European Affairs. The following chart shows the organizational embedding.

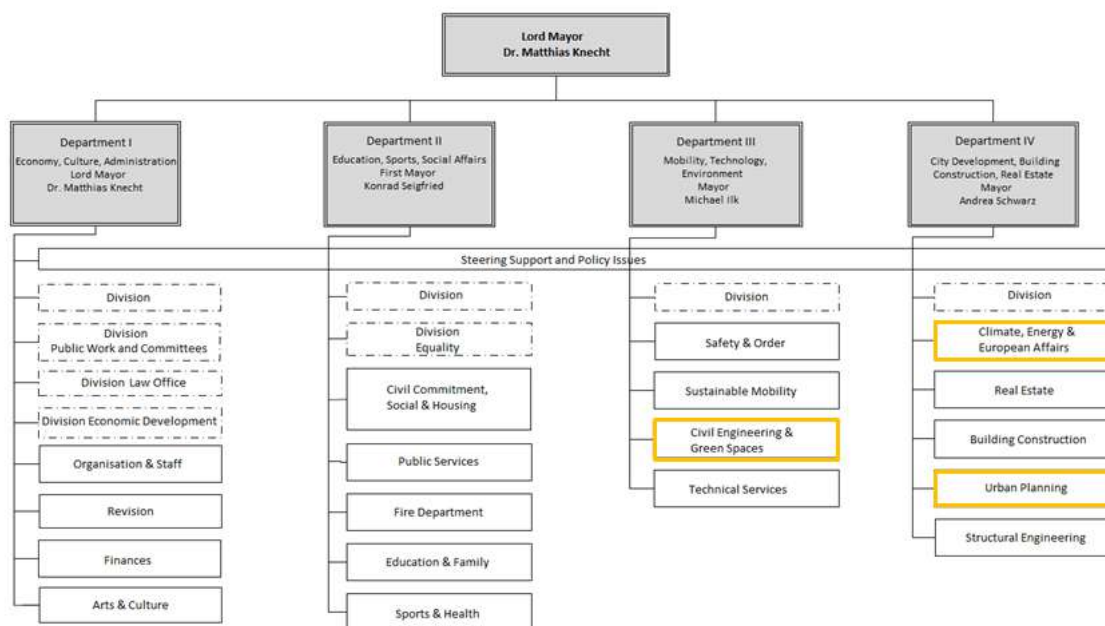


Figure 2.25: Organization Chart of Ludwigsburg, Source: City of Ludwigsburg

The city council of Ludwigsburg has 40 members. It is chaired by the Lord Mayor, who was elected for eight years in September 2019. The Lord Mayor is responsible for the overall management of the city administration. It was completely reorganized in 2018 and is now divided into 4 departments:

- Economy, Culture, Administration (under the direction of the Lord Mayor)
- Education, Sports, Social Affairs (under the direction of the first mayor)
- Mobility, Technology, Environment (under the direction of the second mayor)
- City Development, Building Construction, Real Estate (under the direction of the third mayor with responsibility for construction)

The four departments just mentioned are divided into 17 units. In addition, an interdepartmental unit under the direct supervision of the Mayor's Office was set up in 2008 - the Unit for Steering Support and Policy Issues. This interdepartmental structure was created to change the traditional linear structure of the administration.

There are also five divisions at the City of Ludwigsburg:

- division for Public Relations and Committees
- division Equal Opportunities Officer
- division for Climate, Energy and European Affairs
- division Law Office
- division for Economic Development

They are divided into the respective departments.

The division for Climate, Energy and European Affairs are involved in all decision-making processes related to sustainable urban development. This has resulted in a de facto reform of the administrative structure.

Who is involved in the NBS process?

- Not all departments of the municipalities are involved in the planning and implementation of NBS. The technical planning on which the measures are based is controlled from the Climate and Energy staff unit. The staff unit gives directions to the other departments, which then deal with the planning and implementation. The staff unit accompanies the process and monitors progress of the NBS delivery. The city planners' team decides which measures are to be implemented where in the city. There are responsible persons at the overall city level and in the city districts. When it is clear which measure is to be implemented and where, the green space office takes care of the designing of the measure. As soon as the planning is completed, it is decided by the municipal council and the money is made available. A legal examination is carried out by the Building Law Office. Once approval has been granted, construction can begin. In most cases, the department that was responsible for the planning also takes over the management of the construction project. If the measure cannot be implemented by the Technical Services, an external company is commissioned.

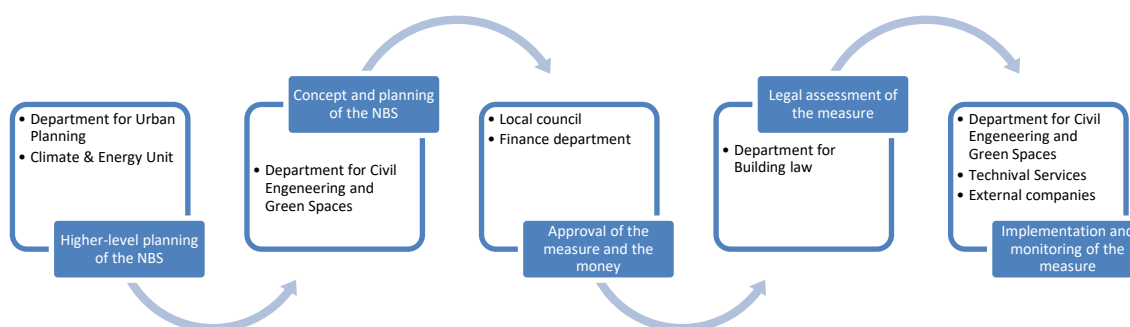


Figure 2.26: Important tasks and stakeholders

2.1.3 How we developed this plan

At the beginning of the chapter it is shown which are the biggest problems Ludwigsburg will get due to climate change. The issues of heat, floods and heavy rainfall are particularly important for Ludwigsburg. This was recognised several years ago and concepts and strategies were developed to manage the challenges.

As shown in this chapter, there are different specialised concepts and plans in Ludwigsburg that strongly shape the city's work in the field of climate adaptation. The RUP takes all these documents into account as a basis and the proposed measures are derived from the existing foundations. However, the KliK and the FEK are particularly important. The KliK in particular already contains many concrete measures that only need to be implemented in reality. Since the list of measures is very long and extensive, the opportunity can be taken to prioritise the measures for the next few years with the help of the RUP.

In order to develop the RUP, three departments within the administration are needed. These are Department 67 "Civil engineering and green spaces", Department 61 "Urban planning and surveying" and "Climate, Energy and Europe Unit". The Climate, Energy and Europe Unit is responsible for the preparation of the RUP.

Together they looked at what data and bases already exist. These were prioritised. In Ludwigsburg, there are already many ideas for good NBS. The concepts were reviewed and compared with the targets which were defined for the RUP. The result was a clear picture of which topics and measures should be included in the RUP. The strengths and weaknesses within the administration with regard to the implementation of Nature-based Solutions were also discussed.

In July, some measures were discussed with the citizens. The main focus was on protection against heat in the city. Unfortunately, due to the COVID-19 situation, no further participation of citizens was possible. During the two-hour online event, citizens were able to share their views on different measures to help reduce the heat. This gave a clear picture of which measures residents were in favour of. Planting trees, installing solar sails and creating pocket parks were frequently mentioned measures.



2.2 Target

2.2.1 Targets for the RUP

Three focal points for Ludwigsburg were identified as the greatest challenges with regard to adapting to the climate. These are:

- Air quality, especially in the city centre
- Heat, especially in summer
- Heavy rainfall
- Noise pollution, especially in Eglosheim

Quality of Air

Clean air is an important strategic objective addressed by the city's programmes on electro mobility, energy and green areas. The city's aim is to fully observe legal limits (EU and national) and to avoid long-term exceedances.¹⁰

- Limit value PM 2,5: 25 µg/m³ as annual mean value
- Compliance with the PM10 daily limit value (daily mean values above 50 µg/m³ must not occur more often than on 35 days per calendar year / margin of tolerance: 25 µg/m³ PM10 by 11.06.2011 for stations in areas with confirmed deadline extension) or with regard to the annual limit value (40 µg/m³ PM10 per calendar year / margin of tolerance: 8 µg/m³ PM10
- The annual air quality limit value for nitrogen dioxide (NO₂) for the protection of human health is 40 micrograms per cubic meter

A high air pollution is a problem in Ludwigsburg due to the poor ventilation of the city. There are two measuring stations monitoring the concentration of NO₂, PM2,5, PM10 and O₃.

The city of Ludwigsburg has not set its own limit values and targets for air quality. Here, the city orients itself to the European and national limit values. The EC Air Quality Directive (Directive 2008/50/EC on ambient air quality and cleaner air for Europe of 21 May 2008) came into force on 11 June 2008. The member states are obliged to draw up clean air plans for areas in which the limit values and tolerance margins for air pollutants specified here are exceeded.

The requirements under European law were transposed into German law by amending the Federal Emission Control Act (§§ 44 to 47 BImSchG) and by enacting the Ordinance on Air Quality Standards and Emission Ceilings (39th BImSchV) on 25 January 2010.¹¹

The goal for the RUP would therefore be to at least reach the legal values.

¹⁰ EGL 2018: 26

¹¹ Source: Umweltbundesamt <https://www.umweltbundesamt.de/themen/luft/regelungen-strategien/luftreinhaltung-in-der-eu#beurteilung-und-kontrolle-der-luftreinhaltung-in-der-eu>



Heat waves

Because of climate change the average temperature in Ludwigsburg is projected to increase about 2,5°C by the year 2100. The number of heat days (days with more than 30°C) will increase from 8 to about 30 days per year. On such days the extreme heat means stress for the body and can lead to health damages. This will be particularly challenging in urban settings which will feel the additional effects of the urban heat island effect. Older people and children are especially affected by the heat, which becomes an important risk to manage in view of forthcoming demographic change in Ludwigsburg.

In Germany - in contrast to air quality - there are no limit values for the issue of heat. Neither the state of Baden-Württemberg nor the city of Ludwigsburg have defined concrete values or targets for a heat-adapted city.

The target for the RUP can be defined that the goal of the city of Ludwigsburg is to minimize heat islands as far as possible and to preserve important cold air corridors in the city.

Heavy Rainfall

The number of extreme weather events will increase due to climate change. In the case of heavy rainfall events, flooding is also possible in areas that are not on a river. Areas that are heavily sealed are particularly at risk. These are often industrial areas and the inner city.

The goal for the RUP is to unseal as many areas as possible to facilitate the runoff of water in the city. In addition, the goal is to reduce flood risk on the Neckar River so that heavy rainfall can be mitigated naturally.

2.2.2 Existing targets

Integrated Climate Protection and Energy Strategy (iKEK)

In addition, the iKEK sets out concrete goals for the City of Ludwigsburg based on an update of the scenarios for the development of energy consumption and emissions up to 2050. The measures for achieving these goals are divided into eight fields of action. They are listed in longer or shorter profiles, depending on priority. The evaluation of the fact sheets, which is provided on the basis of various criteria, additionally illustrates the prioritisation of the measures.¹²

The overarching goal is for Ludwigsburg to be climate neutral by 2040 at the latest. All the measures in the concept are designed to achieve this goal.

Climate adjustment concept (KliK)

The aim of KliK is to maintain the city's quality of life and to make it more liveable in certain areas. This can be achieved, for example, by ensuring a high quality of life in public spaces despite changing climatic conditions. The KliK provides packages of measures with many implementation steps, e.g. the development of a concept for decentralized rain water

¹² iKEK 2019: 4, 40



management. The concept should contain the runoff and retaining in open areas, retaining through greened roofs, watering from green areas, usage of rain water for lavatory flush or cooling of facilities.¹³

Acoustic environment

Concerning noise, the masterplan mobility foresees the subsequent reduction of the amount of people affected by noise. Hereby especially the adherence to values and recommendations stated in the EU Environmental Noise Directive is of high importance for Ludwigsburg.

The city council therefore adopted a noise action plan in 2015, proposing a strategic and comprehensive approach on the reduction of noise.

The Action Plan foresees the following steps:

- the extension of 30 km/h speed limit zones during day and/or night (ca. -2,5 dB(A))
- the use of low-noise asphalt, wherever possible (- 3 to - 5 dB(A)). Review of a city transit ban for lorries
- an improved traffic management (e.g. green wave signalization) and the displacement or bundling of noise through optimized traffic concepts
- the evaluation and preservation of quiet area¹⁴

2.2.3 How this RUP can be helpful

As already explained, there are several existing strategies in Ludwigsburg that aim to adapt the city to climate change and to protect the climate. The climate protection concept includes concrete measures, with contact persons and timings. The concept for climate adaptation includes a wealth of possible measures, but these are not specified. At this point, the RUP makes an important contribution to delivering measures that serve climate adaptation and at the same time are helpful for climate protection. The RUP contains a clearly defined number of NBS actions that are important for the city. These NBS deliveries are derived from the most important goals of our wider suite of strategies. The RUP thus represents a roadmap for using NBS over the next three to seven years to support a number of key strategic objectives. If funds are available or there are funding opportunities, the departments can take a look at the RUP and select a measure. The RUP thus represents an important roadmap for the next few years in the implementation of concrete climate adaptation measures in Ludwigsburg.

How will the RUP be used?

This RUP is intended to be known across the organisation. This means that all relevant departments are familiar with the RUP and can take it into account in their daily work. The RUP should serve as a source of inspiration for the entire city administration, because the most important aspects around the topic of climate change are relevant for everyone. The RUP is therefore published on the intranet so that it can be used by everyone.

¹³ KliK 2016

¹⁴ EGL 2018: 25 et seq.



Furthermore, concrete tasks and responsibilities are derived from the RUP. Who is responsible for what and when? These tasks are entered into the city's project management tool KASIS. In this way, the tasks from the RUP are fixed and implementation takes place as planned.

The RUP can be used as a complementary document to make the green solution more concrete. Moreover, the RUP is considered a store of ideas for colleagues. It is helpful for the work of the district officers.



2.3 Adopted Solutions and Expected Impact

2.3.1 Focus districts for this RUP

Ludwigsburg has very different districts, all of them are facing different challenges in relation to climate change. Some parts of the city are more affected, others less. However, the **inner city area** is affected several times, because it is particularly hot here in summer and there is quite a high level of air pollution. The inner city is therefore a focus for the implementation of NBS. Many people work, shop or live in the city centre. Numerous tourists also visit the Ludwigsburg city centre. NBS have an important role to play in ensuring that people enjoy staying in the inner city and can live healthy lives there in the future.

The **Eglosheim** district is a bit outside, near the motorway. This leads to a very high level of noise pollution in the district. In addition, Eglosheim has a large industrial area that is heavily sealed. This means that Eglosheim will suffer more from the heat in the future, because it experiences strong heat island effects in summer. It makes sense to take measures that reduce the noise and heat.

Neckarweihingen is a very special district because it is the only one that is located directly on the Neckar. The town centre of Neckarweihingen is still quite historic, but there are more and more new buildings. Due to the direct location on the Neckar, parts of Neckarweihingen are in great risk of flooding. The older buildings in particular rarely have protective measures. For this reason, there should be NBS implemented in Neckarweihingen, which ensure that the Neckar does not overflow its banks.

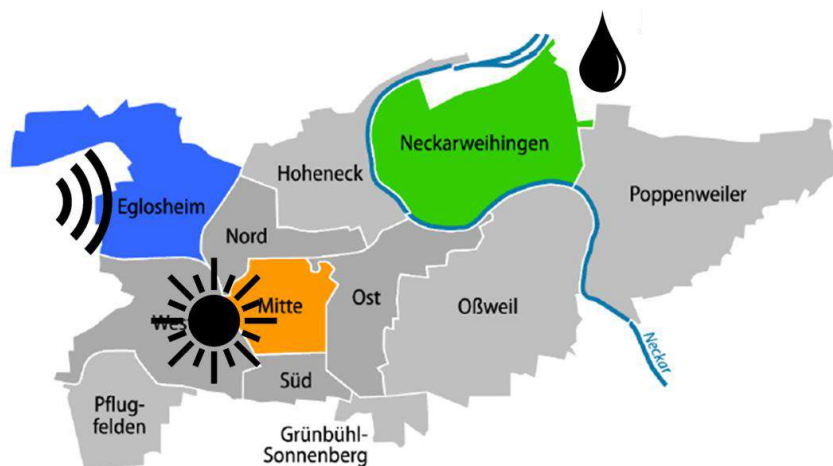


Figure 2.27: Focus districts in the city of Ludwigsburg

2.3.2 Solutions

There are a number of possible measures that can be implemented to achieve the desired goals. In the following, a few selected NBS are briefly described, which are considered to be expedient and useful for Ludwigsburg.

Measures Overview

- Greening of the Court of Honor
- Redesign of the Arsenal & Schillerplatz
- Bärenwiese - city park instead of parking
- Green Sunsails for the pedestrian zone
- Mobile Greening
- Green noise barrier
- Redesign of the Neckar river bank
- 100 trees in one year - 1000 trees in 10 years

Some of the actions listed here were inspired from actions by other URBAN GreenUP cities. We noticed that solutions do not always have to be found by ourselves, other cities have already thought of or implemented good measures. In this way, Ludwigsburg can benefit from the experiences of other cities.

For example, the city of Mantova has already carried out a similar unsealing measure with greening, as Ludwigsburg is planning for the Ehrenhof. The project is called "Via Tasso". Valladolid has also approved a major redevelopment in the city centre, the "Estadio Municipal", what has been changed for climate adaptation reasons. The cities of Liverpool and Mantova have already implemented a type of mobile greening. This is very inspiring and Ludwigsburg can benefit from the experiences of the other cities, from the type of elements to the plant species.

NBS planned for the inner-city area

- *Greening of the Court of Honor (Der Ehrenhof)*

The courtyard of honor is an area in the city centre next to the city hall and in front of the theater "Skala". Currently, there are parking spaces in the area.



Figure 2.28: left: Heat stress in the city centre; right: Drawing of the Green Court of Honour; Source: City of Ludwigsburg

The Court of Honor always heats up very much in summer, because there is not much air exchange here.

In the inner city, the potential of the inner courtyards is to be developed. The former gardens are now mainly built on and sealed by traffic areas. Unsealing and greening the Court of Honor can increase the quality of stay and contribute to improving the urban climate. As a public urban garden in a central location, it offers space for outdoor urban culture.

The Court of Honor was already temporarily greened in the summer of 2020 as part of the application for the State Garden Show.



Figure 2.29: Current parking situation in the Ehrenhof; Source: City of Ludwigsburg



Figure 2.30: Pictures of the temporary measures in the Court of Honor; Source: City of Ludwigsburg

In the first pictures it can be seen the current status at the Ehrenhof. The picture below shows the pop-up measures from 2020. The measure was implemented temporarily to illustrate the added value of the measure. After two months, the lawn and the greenery were removed.

The goal of the NBS is to unseal a large portion of the area and permanently revegetate it with grass and plants. The model for this is the pop-up greening from 2020, as seen here in the picture.

Thus, the square should no longer be a heat island, but also a pleasant place to stay in the summer. The place should be multifunctional. This means that no fixed furniture is planned. The green square can be used for outdoor events of the theater, as a green meeting room for the administration or as a quiet oasis for the citizens.

Federal funding has been promised. It is planned to implement the measure in spring 2022.

Costs: 220,000 Euros

- *Redesign of the Arsenal & Schillerplatz*

Very centrally located in Ludwigsburg's city centre are Schillerplatz and Arsenalplatz. Arsenalplatz is currently a parking lot and Schillerplatz is the forecourt of a bank building. They are located on a connecting axis that links the train station with the stores and offices in the city centre. The current situation is characterized by a lot of traffic and concrete. The areas heat up very much in the summer and are not pleasant places to spend time.

In order to improve the local situation and make the city centre more attractive, the two squares will be redesigned. The redesign should fulfill the following goals:

- nearby green space for refueling while shopping
- intergenerational outdoor meeting place
- multi-functional space for events
- natural air conditioning on hot summer days in the urban space
- urban park for lunch breaks and children

A realization competition for the area has already taken place. Three winning designs were selected. The 1st prize winner has planned a grove of trees for the "green space" of Arsenal Square. The other winners propose a classic green space in this place.



Figure 2.31: Idea of the 1st prize winner MANN LANDSCHAFTSARCHITEKTUR, FULDA

- *Bärenwiese - city park instead of parking*

The "Bärenwiese parking" is located between the castle and should be transformed into an urban park. Up to 15,000 m² additional green space will be created. The parking is to be relocated to a parking facility, the park area is still there available for large city events. Through this a large additional inner-city green area is created.

Costs: 1.5 Million Euros



Figure 2.32: Images from the feasibility study for the State Garden Show

- *Green Sun sails for the pedestrian zone*

Especially in summer, a lot of people move around Ludwigsburg's city centre. Many tourists are out and about in the city. However, most of them do not stay there for very long because it is too hot for them. For this reason, it is important that strolling through the city centre becomes more pleasant for people. Then they stay longer in the city and spend more money there. So, shading the pedestrian zone seems to make sense. Since it is not possible to plant trees, sun sails can provide shade in the summer. When greened, the sails have a double cooling effect and will brighten up the somewhat colourless downtown.



Figure 2.33: Example of GREEN AWNINGS from Valladolid; Source:

<https://www.urbangreenup.eu/news--events/news/municipal-plan-to-install-green-awnings-this-year-with-1-5-million-investment.kl>

- *Mobile Greening*

There are several large squares in the inner city that heat up a lot in the summer. Some of the squares are historic and therefore cannot be easily converted. In addition, the squares are needed for events. The squares include the market square and the town hall square. Large, very traditional events take place on these squares. Nevertheless, the heat is a big problem. In addition, water can only run off poorly due to the large sealing. However, since the squares cannot be permanently rebuilt, a mobile greening system is an option. This can be removed during events and otherwise serves its purpose. It provides shade and generates evaporative cooling. It also absorbs water. The green elements are best combined with seating. This creates a temporary city oasis.



Figure 2.34: Example of movable trees Source: <http://www.wanderbaumallee-stuttgart.de/>

For Eglosheim

- *Green noise barrier*

The district of Eglosheim is characterized by the passage of the B27 with up to 70,000 vehicles daily. A noise barrier should be built, which takes a new ecological approach. This highly absorptive noise barrier combines the function of noise protection with important ecological functions and climate adaptation measures with a small space requirement.

The planned, certified noise barrier is a noise barrier that has already been greened in advance during construction. In addition to the noise to be absorbed, it also provides ecosystem services in addition to the noise as well. In the "Green Room Ludwigsburg" successfully researched as part of the EU research project TURAS. With the system Helix® Elementa' as a modular system, the desired shape can be created with structurally stable wire baskets that have been wire baskets pre-cultivated in a nursery. The planned green noise barrier is exemplary. On a



Figure 2.35: Example of the green noise barrier

surface area of 0.5 m², 8.5 m² of 8.5 m² of species-rich green space is created vertically, which serves as a CO₂ sink.

Costs: approx. 1 Million Euros

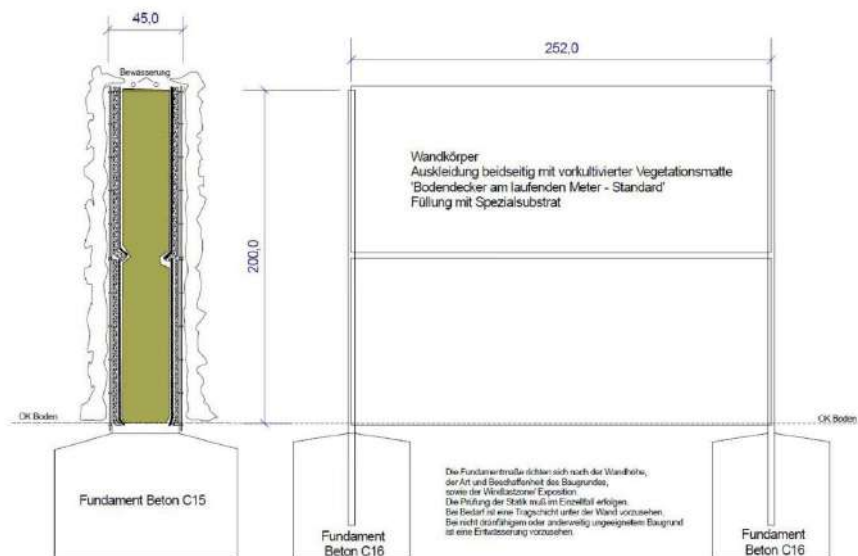


Figure 2.36: Technical drawing of the noise barrier

For Neckarweihingen

- *Redesign of the Neckar river bank*

From the riverbed to approx. 1m above the backwater level the bank of the Neckar is a continuous concrete wall. This type of shoring is found on large stretches of the Neckar. Due to the large areas of mineral, dense surface, the proportion of living areas is very small. Consequently, there are very few cavities. There are almost no typical habitats for the aquatic fauna and flora.

The aim of the measure is to take into account and harmonize the different demands of water ecology, local recreation, navigation, flood protection and climate adaptation in equal measure and to fulfil them in the best possible way. To achieving the goal, the riverbank of the Neckar - which is not in its natural state - is to be designed in a near-natural way and integrated into the park.

Costs: 1 Million Euros



Figure 2.37: Current situation on the Neckar



Figure 2.38: Sketch for the redesign

For the whole city

- *100 trees in one year - 1000 trees in 10 years*

Throughout the city there are sites that are suitable for planting with new trees. Already in 2020 100 new trees were planted within the Green Ring. The aim of this measure is to strengthen biodiversity and climate adaptation and additionally improved quality of life for the residents of the city.

Costs: 100,000 Euros per year



Figure 2.39: Possible tree locations

2.4 Legal barriers and other constraints

There are often several barriers to overcome in the implementation of NBS. These barriers are often of a legal nature, but political, financial, organisational and social aspects also play a major role.

2.4.1 Assessment of the situation

Legal barriers exist for every new construction and conversion of buildings. For example, one legal barrier is a national building law BauGB (Baugesetzbuch). Its provisions have a great influence on the shape, structure and development of the populated area and the habitability of towns and villages. It is very detailed and gives precise instructions on various aspects of construction. In particular, the regulations on fire protection and traffic safety provide precise details on how buildings and greenery should be designed. These can limit the application of NBS in the following ways:

- Conversion is not permitted for historic reasons
- Implementation is not permitted for safety reasons
- Another law does not allow the encroachment e.g. in road space

Besides for any new area, there is a legal duty to have a local development plan. In Ludwigsburg, every new building should have a roof greening by law. Furthermore, in the inner city there is a special design constitution (Gestaltungssatzung). The bylaws regulate the design of buildings. It is not possible to simply change the façade, for example, to put greenery on it. This must first be permitted by the statutes.

The political and financial barriers are closely interlinked. The topic of climate adaptation and therefore the implementation of Nature-based Solutions are not compulsory tasks of the administration in Germany. Compulsory tasks are all the things the administration is obliged to do for example to build schools or offer public transport. Municipalities always plan a fixed budget for these compulsory tasks, whereas no fixed budget is set for other tasks, such as the implementation of NBS. Therefore, it is not that easy to convince the municipal council to allocate funding to NBS.

To what extent a City implements things in this topic depends in Germany very much on the budget of the City. But even for Cities which are financially stable (and Ludwigsburg is one of these Cities) it is a barrier to convince politicians to give money for this. For this reason, Ludwigsburg often needs funding programmes from higher levels of government to implement NBS.

Another barrier are organizational structures. To implement Nature-based Solutions different municipal offices have to work together and have to agree with a measure. Often there are different interests. It gets even more complicated if parts of an area are owned by the state or private persons. It is a barrier to convince all the different stakeholders. But of course, there are also examples of success: for the renaturation of the river bank of the river Neckar in Ludwigsburg coordination processes between federal government (owner of the river) and the



City (owner of the river bank) were necessary. In this project they worked closely and successfully together.

Not least there are also social barriers to overcome. Our experience is that citizens are often very critical if something is in a testing phase. If the City spends money in new and innovative solutions they are often not perfect. Often citizens ask “why do we have to spend so much money on such things? Aren’t there more important things to do?” Here the communication is very important and challenging.

2.4.2 Proposed initiatives

Some barriers cannot be overcome. These probably include above all the legal aspects, many of which are national laws. But all other barriers are not fixed in laws but are only due to certain structures or ignorance, too little time or money. These are all aspects that can be changed. These are briefly outlined below.

Legal barriers

If the GauGB does not permit a measure, then the measure must be adapted so that it can be legally implemented. In principle, the law can always be weighed up and interpreted, but no fundamental aspects may be revised by the municipality.

The city has an influence on its development plans. These can be changed. However, these statutes have normally been in existence for more than 20 years. So, it is not easy to change the legal situation quickly.

Political barriers

Convincing the municipal council of a measure requires a lot of communication and information. The members must be involved from the beginning and the added value of the measure must be clearly communicated to them from the start. Analyses and simulations that show how the city will change as a result of climate change serve this purpose. In this way, the issues become more tangible and it becomes clear that it is important to adopt solutions.

Financial barriers

Often there is the will in politics to implement a measure, but there is a lack of money. It is therefore helpful to show how the measure can save money in the long term. Because consequential costs that arise from climate change are avoided. In addition, there is the possibility of reducing costs with the help of funding projects. For example, the federal government or the state of Baden-Württemberg take over a share of the costs and the city only has to make a small contribution of its own. Often, supportive funding helps to convince politicians to make money available to implement a measure.

Organisational barriers

In order to implement a NBS, many departments of the city administration are needed. All have to work together very well in order to implement the measure quickly. However, the measure is one of many measures that are also waiting to be implemented. Therefore, good



project management is needed, which structures the processes well and keeps the overview. There must be clear responsibilities as to who performs which task and when. In addition, the project must be supported by the municipal council and the top management. This creates a high level of motivation to implement NBS. In addition, enough staff is needed so that the measures can be implemented.

Social barriers

The issue of climate change and climate adaptation are very complex processes. Climate change is difficult for the public to grasp and the topic is very abstract. The threat can seem abstract and far away, so it is not clear to the public why the city is investing so much money in NBS. For this reason, it is very important to have a good communication strategy. This must educate the population about the issues and raise their awareness; in some cases, it may be possible to involve citizens in co-creation of our city's NBS assets. This way, the NBS will get more recognition and will be supported by everyone in the long run. In the best case, citizens will start implementing measures on their own.



2.5 Programme and Budget

The costs for each measure have already been briefly described in the chapter "NBS". These are summarised below.

| Planned measures | Costs |
|--|----------------------------|
| Greening of the Court of Honour | 220,000 € |
| Redesign of the Arsenal & Schillerplatz | forthcoming |
| Bärenwiese - city park instead of parking | 1,500,000 € |
| Green Sunsails for the pedestrian zone | 100,000 € |
| Mobile Greening | 50,000 € |
| Green noise barrier | 1,000,000 € |
| Redesign of the Neckar river bank | 1,000,000 € |
| 100 trees in one year - 1000 trees in 10 years | 100,000 € |
| Total costs | Approx. 3,970,000 € |

Table 2.1: Summary of planned measures

Some of the planned measures are classically financed through the municipal budget. However, there are also measures that rely on innovative methods.

Funding

The city of Ludwigsburg has applied for funding to implement the Green Court of Honour project. This is a federal grant that can be applied for. You only have to pay a contribution of 10 % if you are awarded the grant. However, the project will be realised even without the funding, but at a later date, because no money is currently budgeted for the project. Funding is also being sought for the green noise barrier

Sponsorship

A local bank wants to plant trees as a sign of climate protection. This resulted in the campaign 100 trees a year - 1000 trees in ten years. The costs for the trees are covered by the bank. The city and its employees take care of the planting and maintenance.

Public-Private-Partnership

The aim is to realise the green sun sails in the pedestrian zone together with the shops in the city centre. The measure is planned and financed together. In this way, the costs are shared by many and are very manageable for the individual. The participation of the shops is also intended to increase the acceptance of the solar sails. In this way, it is possible to jointly come up with an attractive solution that best suits for the city. Due to the COVID-19 crisis, the shops in the city centre are not in a good financial position. For this reason, it may take some time before implementation in the PPP model is possible.



2.6 Stakeholders (roles and responsibilities)

2.6.1 Additional Institutions with a role in NBS

The main institution in implementing NBS is the city administration of Ludwigsburg. If buildings or land of the state of Baden-Württemberg are concerned, the corresponding institutions will be involved as well. Some Environmental Associations, private organised projects and projects supported by local companies are playing an important role as well.

Environmental Associations

A local branch of Environmental Associations in Germany is located in Ludwigsburg. Including Friends of the Earth Germany (BUND)¹⁵ and “Nature and Biodiversity Conservation Union (NABU)”. These NGOs accomplish important nature conservation work on site with the support of many volunteers. The main area of responsibility is care activities of green areas and tree populations as well as educational work regarding environmental and nature conservation-based topics.

The Urban Gardening Project¹⁶

In March 2013 some hobby gardeners found a community garden called “stattGarten” (engl.: “instead of garden”). The aims of the Urban Gardening Project, which is located in Eglosheim, are the ecological cultivation of fruits, vegetables and herbs to use for self-sufficiency and the creation of a place for communication, interaction and experimentation for all people in society.

Another Urban Gardening Project is called “Unser Stadtbeet” (engl.: “Our City Patch”), it was found by two students of the evangelical university. Inhabitants living close to “Unser Stadtbeet” are cordially invited to planting their own fruits and vegetables. This project cooperates with a school and enables therefore to show the students how much work and time is needed to grow and harvest food. Hereby it is possible to strengthen the awareness of the students regarding their consumer behaviour.

In this way, citizens are involved in the work around NBS. They get involved in the measures themselves and they find more support in the political arena. Because these are measures by the citizens with the citizens for the citizens.

Greenway Sponsors¹⁷

Dedicated sponsors ensure the preservation of the picturesque recreational area. While the Greenway Ludwigsburg-Pflugfelden with its park-like green areas adjoins on extensive fields it enriches the environment and increases the quality of living in Pflugfelden. In the past few years, it has been possible to preserve old tree populations in particular. Continuous path links,

¹⁵ <http://bund-ludwigsburg.de/>

¹⁶ <https://www.ludwigsburg.de/,Lde/start/agendabuero/urban+gardening.html>

¹⁷ <https://www.ludwigsburg.de/,Lde/start/agendabuero/gruenzug+pflugfelden.html>



playgrounds, benches, rest areas for people, plants and animals (e.g. with a bee hotel) make the green area a unique recreational area.

Institute of Landscape Planning and Ecology¹⁸

The field of work deals with the characteristics and development of urban landscapes, based on an understanding of ecosystem processes. The main research areas of the institute are the development and testing of methods of design research and landscape modelling for the planning and design of sustainable habitats. The institute develops methodical-strategic contributions to the development of cross-scale and interdisciplinary tasks resulting from the combination of requirements of the ecosystem landscape budget and the sustainable development of infrastructure systems with a functional as well as aesthetic design of landscape. In cooperation with the Institute of Landscape Planning and Ecology a so called “green room” was invented in 2014, see more in section 2.1.2.5.

Citizen engagement

Citizen participation has a long tradition in Ludwigsburg. The SEK is developed in a “trialogue” between citizens, administration and politics. Future conferences are held at regular intervals. At these events, citizens can actively contribute their ideas and wishes. To ensure that the ideas developed by the citizens are put into practice, Ludwigsburg has a project management tool called KSIS, in which the individual measures are assigned to the responsible departments and persons. Citizens can also take a look at the system online to see which tasks are being handled by whom and when. The aim is to create as much transparency as possible.

In December 2020, the strategy process "Ludwigsburg goes further" (“Ludwigsburg geht weiter”) was launched. The aim of the process is to fundamentally revise the SEK and to find new goals and measures. So far, the goals and measures have been formulated quite generally. This should change through the process. The goals and measures are to become more concrete. An important topic of the strategy process is also the topic of climate. This means that there are different formats in which citizens can express themselves on the topic of climate adaptation and climate protection. Two events on the topic of climate have already taken place in Ludwigsburg.

One event focused on the topic of heat adaptation. Together with the citizens, green solutions were developed to protect the city from the heat. The population has very good ideas and it is important to listen to them and incorporate them into the process. For this reason, a digital survey is also taking place in which citizens can draw particularly hot and cool places on a city map. At the same time, citizens can vote on which climate change adaptation measures they prefer. This creates a good overview of which measures should be tackled next.

Due to the COVID-19 situation is not clear how many events can still take place. However, the goal is to discuss the biggest challenges together with the population and to find good

¹⁸ <http://www.ilpoe.uni-stuttgart.de/institut/index.html>



solutions together. The ideas from the RUP will also be presented to the population in this way.

In addition, Ludwigsburg has good contact with the citizens through the district representatives. These are people from the administration who look after a district specifically from a planning and social point of view. They are in close contact with the local people, associations and businesses. In some neighbourhoods there is a small budget, which is managed by the citizens. Here, the citizens can decide what the money is used for. One idea is to use this budget to promote NBS in the districts. The citizens bring in ideas and get them fully or partially financed. The aim is for the citizens themselves to work on the measures and shape them. In the long term, these should also be maintained by the citizens themselves. This creates a close link between the measure and the people who live there.

2.6.2 The implementing departments

To give a better overview of which stakeholders are involved in which section of the planning process, two tables are presented below.

The departments listed here are the most important when it comes to implementing NBS. These three departments need to collaborate closely and share information if NBS delivery is to be successful. The Climate and Energy department sets a direction based on the climate adaptation concept. Department 61 (Urban Planning and Surveying) takes this up and shows where in the city it would make sense to implement the NBS. Department 67 (Civil Engineering and Green Spaces) is responsible for the design, execution and maintenance of the NBS. The department must therefore be involved in the considerations from the very beginning.

For this reason, these three departments were closely involved in the development of the RUP. Together, the measures were defined. The three departments also play an important role in the implementation, as outlined below.

| Stakeholders in the co-creating of the plan | |
|---|---|
| Climate, Energy and Europe Unit (ger. Stabsstelle Klima, Energie und Eurpa; short: KuE) | <ul style="list-style-type: none"> • Central coordination and organisation • Overall responsibility |
| Department 67: Civil engineering and green spaces (ger. Fachbereich 67 Tiefbau und Grünflächen) | <ul style="list-style-type: none"> • Concrete implementation • Design • Implementation |
| Department 61: Urban planning and surveying (ger. Fachbereich 61 Stadtplanung und Vermessung) | <ul style="list-style-type: none"> • Planning • Allocation of Areas • Clarification of questions concerning ownership and the development plan |

Table 2.2: Table of stakeholders in the co-creating of the plan

When it is clear that a measure is to be implemented and at which point in the city more departments are needed. Depending on the type of measure, another department is informed



and involved. For this reason, a larger number of departments are involved in the implementation. The RUP is presented to these departments. It should be considered in their daily work, in such a way that all measures are implemented one by one. Each department has a specific task for this. This is explained in more detail in the table.

| Stakeholders in the implementation of the plan | |
|---|--|
| Climate, Energy and Europe Unit (ger. Stabsstelle Klima, Energie und Eurpa; short: KuE) | <ul style="list-style-type: none"> • Examination • Supervisory body |
| Department 67: Civil engineering and green spaces (ger. Fachbereich 67 Tiefbau und Grünflächen) | <ul style="list-style-type: none"> • Commissioning and contracting of services / construction companies |
| Urban drainage Ludwigsburg (ger. Stadtentwässerung Ludwigsburg ; short SEL) | <ul style="list-style-type: none"> • SEL belong to department 67 • Regulate all questions concerning waste water etc. |
| Department 61: Urban planning and surveying (ger. Fachbereich 61 Stadtplanung und Vermessung) | <ul style="list-style-type: none"> • Accompaniment of the process • However, the central role lies in the planning |
| Department 60: Citizens' office for building (ger. Fachbereich 60 Bürgerbüro Bauen) | <ul style="list-style-type: none"> • Examination of building law requirements • acceptance of the project at the end of the construction process |
| Economic Development City of Ludwigsburg (ger. Wirtschaftsförderung Stadt Ludwigsburg) | <ul style="list-style-type: none"> • Measures in the city centre are discussed with city centre stakeholders |

Table 2.3: Table of the stakeholders in the implementation of the plan



2.7 Monitoring and reviewing

In order to know whether the intended goals are being achieved, they must be regularly reviewed.

Targets were set for compliance with the guideline values for air quality. In addition, the "heat islands" in the city must be reduced to a minimum. This means that there are no longer any areas that are unhealthy from a human biological point of view. And as many areas as possible must be unsealed so that heavy rainfall does not lead to flooding. Furthermore, areas heavily polluted by noise are to be relieved.

| Challenge | measure progress | Target | Reporting interval |
|-----------------|---|--|--------------------|
| air quality | Permanent data collection with measuring stations | Legal limit values must not be exceeded | annual audit |
| noise pollution | Permanent data collection with measuring stations | Legal limit values must not be exceeded | annual audit |
| heavy rain | Creation of a simulation for a heavy rain situation | Prevent flooding and high water | tbd |
| heat | Regular measurement and simulation of the temperature | Reducing heat-stressed areas must to a minimum | All four years |

Table 2.4: Overview of challenges and measurability

Measurement of air quality and noise pollution

There are limit values for air quality and noise in Germany. In these cases, the targets are clearly measurable. There are also measuring instruments that clearly show whether the goals have been achieved or not. To know whether the goals have been achieved, measurements are taken regularly. The city is obliged to do this because it has to document that the legal standards are being met. These values are collected automatically and we can check them at regular intervals to see whether the measures are having an effect. An annual inspection seems to be a good interval.

With regard to heat and heavy rain, there are unfortunately no limit values in Germany that serve as orientation. Therefore, own standards for measurement have to be set.

No guide value for heavy rain

Two measured values can be defined for the topic of heavy rain. Firstly, the area to be unsealed can be defined and a number of days on which the sewer system is allowed to reach its limits. These two pieces of information are not available at the moment. However, the City of Ludwigsburg will endeavour to define these KPIs in coming months.

Orientation towards the climate analysis

On the issue of heat, the city can use the existing analyses. There is a climate analysis map and a so-called planning information map on the topic of heat. In the plan reference map, areas are marked that are particularly affected by the heat. Here, a biologically undesirable climate



prevails. People in these areas suffer a lot because the heat is not good for the body. For this reason, these heat-stressed areas must be reduced to a minimum. There should be no more heat-stressed areas in the city. The measures listed here will certainly make a valuable contribution to this. Therefore, a new measurement will be carried out after the implementation of the measures. In this way, the effect of the measure can be directly compared with the situation before the implementation. A heavily polluted area should then have become an area with a positive effect and the heat load should have been drastically reduced.

Regulation and planning

Issues in urban land use planning are now also mandatory in Germany. With the 2011 climate protection amendment, climate adaptation was enshrined in law alongside climate protection. In the planning guideline objective of urban land use planning. Climate adaptation as a consideration is specified in § 1a (5) BauGB. This means that the aspect of climate adaptation must be examined for every project that is affected by the BauGB. Climate adaptation can also be an important factor in the decision for or against in the design of a building project.

There is no way to make this aspect measurable. But it is possible to see how many projects have taken climate and environmental aspects into account.



2.8 Integration

The RUP does not include a time line. However, it is important to monitor the implementation of the measures. In a next step, the measures must be prioritised and put into a time schedule. With the climate adaptation concept, a concept is already available that is not backed by a timeline. This makes good monitoring difficult, because without a timetable there is no urge to act.

According to the decision of prioritisation each NBS is assigned to a department so that it can be implemented under its responsibility. For this purpose, the measures are inserted into the urban project management tool.

The project management tool is called KSIS and was developed especially for the city of Ludwigsburg. In KSIS, tasks are entered with deadlines. Each employee knows his or her tasks and when they have to be completed. The employee regularly enters the status of the task into the tool. In this way, all others who are involved in the project can see what has been completed in the project. In this way, superiors can also follow the process of the project transparently. If a deadline is not met, a message is sent to the supervisor and the reason for the delay must be entered. This way, a solution can be found quickly to bring the project back on schedule.

In addition to the control of the NBS in the KSIS tool, a personal exchange on the measures must also take place. The Climate & Energy Unit schedules regular coordination meetings to discuss the status of the projects. This is where all the relevant departments involved in the NBS come together and exchange information. At these status meetings, issues can also be raised and problems solved. At this point, the experiences of the other cities can flow into the process in Ludwigsburg so that a faster implementation is possible.

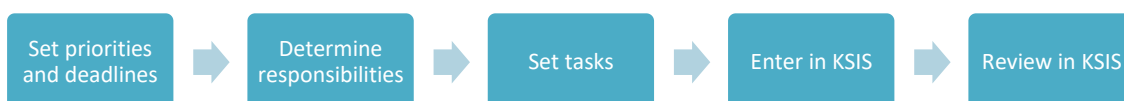


Figure 2.40: Steps of implementation

The goal is for all NBS listed here to have been successfully implemented by 2030.

2.9 Revision of RUP

The implementation of the RUP is scheduled for 10 years. Of course, some things change during this time. Therefore, the RUP must be regularly checked to ensure that it is up to date. In five years (2026), we will therefore look at how far the measures have already been implemented. Depending on progress, further measures may be added or the number of NBS may have to be reduced.



Sources

- Grüne Nachbarschaft: http://www.gruene-nachbarschaft.de/wp-content/uploads/firmengaerten_dokumentation.pdf
- LUBW: <https://www.lubw.baden-wuerttemberg.de/luft/messwerte-immissionswerte#karte>
- LUBW 2: <https://udo.lubw.baden-wuerttemberg.de/public/pages/map/default/index.xhtml>
- Klik 2016: https://www.ludwigsburg.de/site/Ludwigsburg-Internet-2020/get/params_E-1448414285/17957944/Klimaanpassungskonzept_Ludwigsburg_160426.pdf



3 Mantova RUP

3.1 Abstract

This Renaturing Urban Plan (RUP) is a practical guide for the Comune di Mantova to implement Nature-based Solutions in the city. The climate is already changing, and there is an excellent policy framework to use as a guide: this is the plan that will implement the changes the city needs.

This is a plan for action. It describes the challenges to face using high-quality science, as well as the Nature-based Solutions that will be used to tackle these challenges, drawing on the learning of URBAN GreenUP partner cities, and delivering in partnership with the community.

This plan shows the places to put the new Nature-based Solutions in the city, and describes clearly the roles and responsibilities, timelines and budgets for delivery of Nature-based Solutions. It shows how we will prepare our organization, and monitor our success.

We have prepared this plan to help our city manage the effects of climate change, while also improving air quality and quality of life for residents. The Comune di Mantova has worked with residents, businesses, utilities and technical stakeholders such as other public bodies involved in meteorological, safety, territory and environmental departments to co-create the plan.

The main goals of this RUP are:

- a greener city to decrease heat waves effects;
- encourage sustainable mobility and more socialization and wellness, and
- Increase pervious soils to decrease flood impacts.

We developed our plan in three steps.

1 - Understand present situation

- Identification of key stakeholders (e.g. data custodians, territorial planners and decision-makers)
- Review of the principal existing plans and projects
- Collection and analysis of data
- Definition of baselines for future monitoring
- Identification of priority needs and challenges in partnership with our stakeholders
- Measuring challenges and identification of priority areas using mapping

2 - Choose future aspirations

- Worked with our organisation to understand how and where we can implement the NBS
- Selected NBS to implement from NBS Catalogue
- Promoted initiatives inside our organization linked with other National or European projects
- Chose indicators to show our progress



3. Integrate

- Worked in integration in next general urban plan
- Defined roles and responsibilities of municipal dept
- Worked on definition of municipal rules and budget
- Worked in dissemination and upscaling



3.2 Introduction

3.2.1 Why we are making this plan

In this section it is outlined the key challenges we are working to address with this RUP. These include the challenges associated with a hotter, more flood-prone climate, as well as the need to improve water and air quality. It is provided a brief overview of these issues below.

3.2.1.1 Climate Change

Our continental climate has been strongly shaped by the river Po Valley. In the past, winters tended to be long and cold with average temperatures often below zero, as well as intense and persistent fogs. Summers were hot, with average temperatures around 23-26°C, with maximum peaks exceeding 35°C. Precipitation tended to be light, and distributed quite evenly through seasons, although greatest in spring and autumn. In winter, precipitations were sometimes snowy, while in summer thunderstorms were often accompanied by hailstorms.

Nowadays climatic conditions, traditionally characterizing the Po Valley and Mantova itself, have changed, with extreme meteoric events that occur more and more frequently.



Figure 3.1: The River Po Valley, bordered by the Alps (north) and the Apennines (south), shapes Mantova's climate.

Topography of Mantova, in the first picture there is the Pianura Padana Basin, in the second one Lombardy Region and in the last one Mantova territory.

Being enclosed by mountains, the location means that winds are not received from Northern Europe which limits the dispersion of pollutants and natural circulation. This causes increasingly hot summers with storms and frequent hail. Heat island effects are becoming more common, and seriously affect the lives of citizens. Most of the dense urban areas of the city are at high risk of heat island effect and were affected by recent heat waves.

Some examples of climate change effects on territory are in the following pictures of local newspapers: floods, strong winds, hailstorm in Mantova's territory.



Figure 3.2: Newspapers' photo of extreme storms

3.2.1.2 Mincio River Ecosystem

Mantova is built beside the Mincio River, which forms three lakes surrounding the historical centre, and Mincio's Park at the river's northern bank.



Figure 3.3: Lakes surround Mantova on three sides.

As the city has a strong connection with the surrounding river and lake in the area, the city also identifies the conservation of the fragile riparian ecosystem as an important challenge in its development. On the other side, the city comprises a polluted area of national relevance (mainly due to the chemical industrial pole active by the lakeside), with pollution putting the fragile ecosystem to a vulnerable point.



Figure 3.4: Site of National Interest (SIN)

In the Municipality of Mantova there is a polluted site of national interest, called "Mantova Lakes and Chemical Pole". The Sites of National Interest (SIN) are areas that the State has identified as affected by a pollution of particular importance in relation to their extension, the characteristics of the pollutants present and the impact on the surrounding environment in terms of health and ecological risk, as well as prejudice to cultural and environmental heritage. The "Mantova Lakes and Chemical Pole" Site of National Interest was recognized and included in the National Reclamation Program with Law no. 179 of 13 July 2002. The surface falling within the territory of the Municipality of Mantova (9,533,477.48 m²) corresponds to just under 15% of the municipal territory.

The environmental characterization activities carried out made it possible to reconstruct in detail the state of contamination of the land and groundwater present within the Site of National Interest, with the exception of some areas not yet characterized or in which the characterization must be completed.

The data obtained showed a strong contamination of the soils. Contaminants include aromatic organic solvents, organo-halogenated solvents, light and heavy hydrocarbons, MTBE, heavy metals and locally also PCB and PCDD / PCDF.

In 2008, the characterization activities of the lake and river areas included in the SIN were completed, as well as the analyses carried out on sediments, waters, benthos, bivalves and

fish. The main critical issues include the contamination of sediments in the Vallazza lake area. The Ministry of the Environment and the Protection of the Territory and the Sea (now the Ministry of Ecological Transition), as responsible for the reclamation procedure of the SIN, has issued in recent years several decrees approving reclamation projects and operational safety, partly completed and partly in progress. The National Program for environmental remediation and restoration of polluted sites has provided for specific financial resources for the safety measures and remediation of the SIN "Lakes of Mantova and Polo Chimico" which have been governed by various Program Agreements for the definition of emergency safety measures and subsequent reclamation in the "Lakes of Mantova and Polo Chimico" National Interest Site. The last Program Agreement was signed on 12 February 2021 between the Ministry of the Environment and the Protection of the Territory and the Sea, the Lombardy Region, the Province of Mantova, the Mincio Park, the Municipality of Mantova, the Municipality of Borgo Virgilio and the Municipality of San Giorgio Bigarello, whose value amounts to a total of € 18,193,090.91.

3.2.1.3 Air quality

Mantova experiences long periods of low temperature with light winds and thermal inversion of air masses during the winter. These conditions trap air pollutants at the ground level and make winter the time of year with the highest particulate matter concentration. Therefore, every mitigation strategy of pollution must be planned to be effective during winter. Although in the last two decades the Po Valley Regions have appreciably invested in mitigation of air pollution and the concentration of the majority of pollutants has diminished, problems because of PM10 and Ozone (during the summertime) still remain, and concentrations in the Po Valley remain the highest in Europe.

A lot of measures of air quality are also linked to noise problems. In fact, the same pollution sources, such as industry and traffic, also contribute to noise pollution in Mantova. Noise has become, in the last few years, an environmental aspect of particular concern for citizens. In particular in Mantova's central areas, the structure of the settlement and the road pavement made up of cobbles cause a growing phenomenon of noise pollution provoked by vehicle traffic.

It is important to underline that north Italy Regions (Lombardia, Piemonte, Veneto, Emilia Romagna) signed in June 2017 a Program Agreement with Environment ministry to face air pollution and increase air quality to adopt additional remediation measures.

Mantova is also involved in "Prepair project" (Po Regions Engaged to Policies of Air) which involves 18 national and international partners with the goal of promoting more sustainable lifestyles, production and consumption with the purpose of improving air quality.





Figure 3.5: Opportunities and risks to using wood for domestic heating

3.2.2 Overview of key stakeholders and co-creation approach

In the last five years, Europe has embraced the concept of Nature-based Solutions (NBS). The use of ecological features to address problems like heat and flooding is well-recognised. Many of our city's challenges can be addressed using Nature-based Solutions, so we partnered with the European Commission's Horizon 2020 Program to prepare a plan to help use NBS in the city.

This plan is one of many steps for Mantova. We have policies aimed at mitigating and reducing the greenhouse gases, and an overall reorganization of ordinary activities and their impact has begun as a response to climate change. To face these problems Mantova started since 2018 a climate change strategy with The Climate Adaptation Guidelines, based on an analysis of climate and territory risks and vulnerabilities. The study identifies resilience solutions to tackle climate change, and some of these solutions will be NBS. The main problems that Mantova needs to face consequently to its conformation and position, are linked with air pollution, hot summers and heat waves and flooding. This RUP describes a plan to use NBS to address these challenges.

3.2.2.1 How we co-created this plan with our stakeholders and community

Mantova administration believes in transdisciplinary and community-based stakeholder engagement strategy for co-design, co-development and co-implementation of the city's NBS projects. Mantova started the engagement of stakeholders before the production of the city's Adaptation and Mitigation Guidelines. The document is the starting point of the Mantova's

RUP. The engagement-oriented program focuses on the social benefits of engaging with nature, biodiversity and green spaces in cities.

The strategy development process was open and interactive because of climate change studies and urban planning are a developing science, so the process must be open to changes and adaptation processes.

In 2019 Mantova engaged local stakeholders for the plan of SECAP (Sustainable Energy and Climate Action Plan). One part of the document is about mitigation and the other is about adaptation policies and actions until 2030.

The discussion was divided in three different meetings with a different range of stakeholders:

- Institutional
- Commercial and industrial companies
- Cultural, schools and associations

Regarding adaptation and in particular NBS and greening actions, Mincio' s Park, Regional Protection Environmental Agency, Mantova Province, Municipal Police and Urbanistic department of the Municipality were involved in the first meeting. In this meeting stakeholders proposed different NBS regarding a better air quality and green cycle paths.

In the second meeting were involved sanitary structures of the city and industry associations. In the third meeting the discussion was focalized on energy efficiency of buildings.



Figure 3.6: Photographs from local stakeholders meetings

All the stakeholders involved were focused on sectorial territorial governance. For each were defined an area of relevance in order to define their involvement in development of the strategy.

The local stakeholders were divided:

- first with respect the governance territorial system
- second, they were subdivided by their different competence and activities
- this led to a final definition of possible actors and roles in a future plan.

This process is shown in more detail in Figure 3.7 below. Following the analysis of the perception of potential risks, it was possible to define an interpretation key on the basis of which the adaptation guidelines could be constructed.

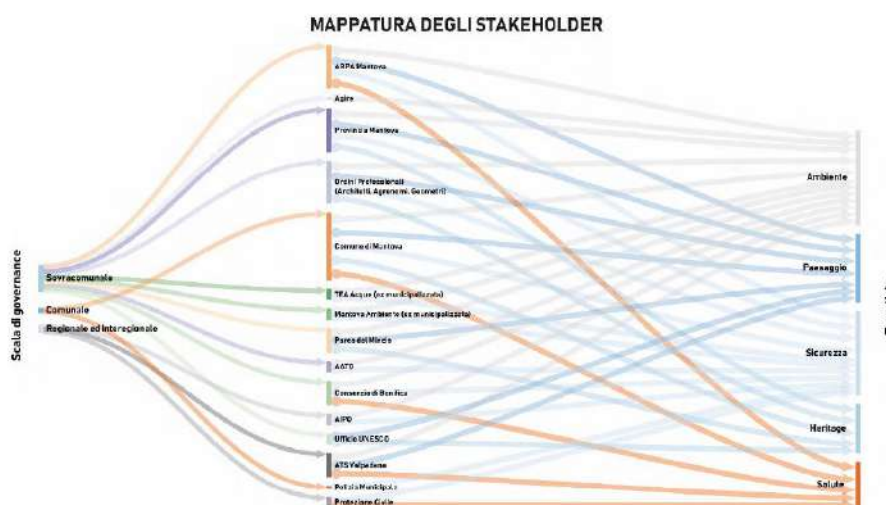


Figure 3.7: Stakeholders map

To reach the objectives and for a better knowledge of the territory and of the actual urban dynamics, it was decided to identify and engage in the project the main actors on the territory next to the municipal departments, particularly:

| Organisation | Interest in the RUP |
|--|---|
| ATS Valpadana (Health territorial department) | Air quality monitoring, health |
| ARPA Mantova (Environmental Protection Territorial Agency) | Environmental aspects, pollution monitoring |
| Mincio’s Park management | Green area management |
| "Territori del Mincio" water management consortium | Surface water management |
| TEA Acque (formerly municipalized) | Water grids |
| Mantova Ambiente (formerly municipalized) | Waste and green maintenance |
| UNESCO office | |
| Province of Mantova | Link with other municipalities, |

| | |
|---|---|
| | dissemination and replication, territorial planning |
| AIPO; PO river Interregional Agency | Management of main water network |
| AATO; Optimal Territorial Scope Authority | Aqueduct and sewer network |
| Civil Protection | Risk management |
| Municipal Police | |
| Professional Orders and Colleges (Architects, Agronomists, Surveyors) | Increasing knowledge and design new solution |
| Municipality of Mantova | Create new plan and rules and disseminate |
| Agire, (energy public agency) | Energy solution |
| Social services | Social effect of climate change |

Table 3.1: Identification of the main actors

Local actors, jointly identified with the municipal administration, have been invited to more thematic meetings, some on specific topics, others more open and with a general recognition nature.

Furthermore, all actors, including the municipal departments, were asked to fill in a simple questionnaire, useful to define the specific problems of the city, but also to determine the understanding and perception degree of the climate issue, with all its territorial and social implications.

How we engaged

There were five meetings with local stakeholders:

- 11.12.2017 - Technical meeting with institutional stakeholder organized by Environmental dept. of Mantova Municipality.

The meeting focused on perception of climate change risks.

- 05.02.2018 - Technical meeting with institutional stakeholders.

After the first meeting Environmental dept. sent a survey to all involved stakeholders. The meeting focused on survey results. There was a direct talk about direct discussion of what was received from the completed questionnaires.

- 19.03.2018 - Specific meeting with ATS "fragile subjects and systems on alert". The meeting took place at the Municipality of Mantova, hosted and organized by the Environmental dept. This informal meeting has involved ATS.

- 23.04.2018 - "Resilient Mantova" - public meeting and workshop.

During the workshop, which was open to population, the important work was carried out to identify the perception of the problems related to the climate in the area.



- 25.10.18 - Public meeting "Resilient Mantova, Climate adaptation guidelines" and workshop. During the meeting was presented to citizens and administration the preliminary results of its work. After the presentations, the participation of citizens was requested to verify the processing adequacy with the perception of those directly living and governing the city of Mantova.

Key decisions

Thanks to the meetings with the territorial actors, to questionnaires and the result of the public workshops, three main issues emerged as predominant and perceived by everyone:

- Storms, with heavy rainfall and violent winds
- Heat waves
- Air pollution

Another important outcome of the meeting was clarifying the central role of the Municipality in addressing local climate issues. From meetings with territorial actors certainly emerged a widespread interest in the issue of climate change and in the impacts that this can cause on territory, both at an environmental and social and economic level. However, despite this recognition, it seems that individual actors were not acting on climate impacts, and above all there was limited activity in terms of coordination for joint operations. Everyone recognizes in the Municipality the right actor for the implementation of coordination on these issues.



3.3 Key challenges in Mantova

In this section it is outlined further evidence of the three key challenges that Mantova plan focuses on: Heat, Water Management (especially flooding) and Air Pollution.

3.3.1 Hot Summers and Heat Waves

From this first analysis it is possible to see how the trend from the beginning of 1900 to today is progressively changing, progressively reducing periods of extended cold, cold days and nights, and peaks of extreme cold (CDD).



Figure 3.8: Cold days (%) in Mantova

The analysis of temperatures confirms that periods of extended and consecutive heat increased dramatically in recent year. Summer days are constantly increasing while hot days (TX90P) and nights are increasing considerably and steadily, especially for extended periods. This clearly leads us to reflect about all the problems related to health and economic activities that these changes can cause.



Figure 3.9: Hot days (%) in Mantova

Other important analyses are those relating to Humidex – a measure of thermal comfort, based on the combination of relative humidity and temperature. This report indicates the perceived rate of thermal discomfort and this information helps to identify heat waves, while the anemometric analysis tells us the characteristics of the wind. These analyses show how in the last few years the discomfort rate increasingly polarized during summer months and how it increased slightly but progressively.

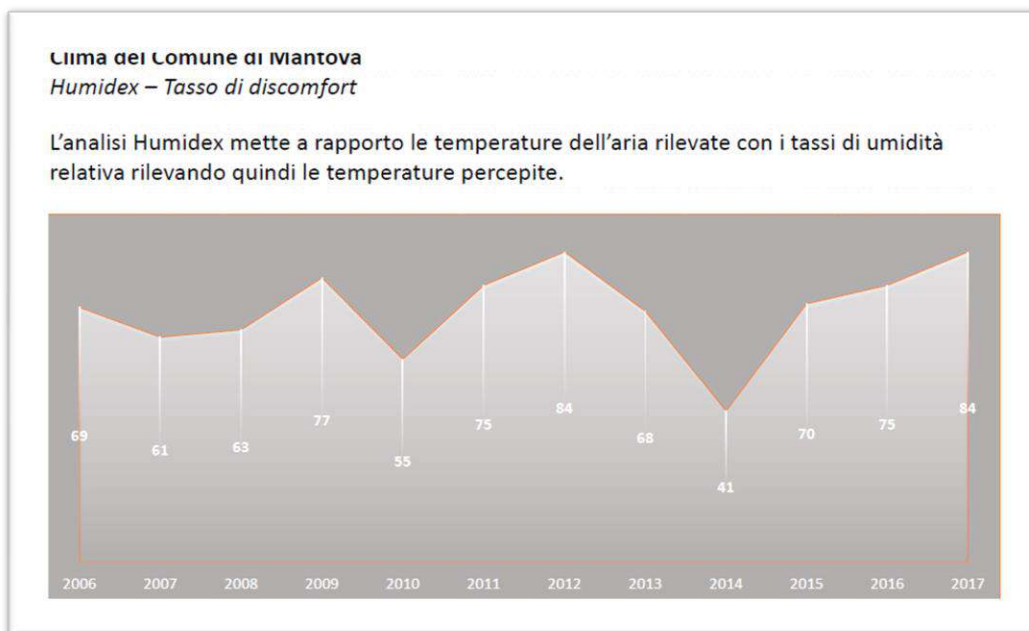


Figure 3.10: Humidex index in Municipality of Mantova

We have also conducted sophisticated mapping of heatwave risk. For the evaluation of the heat wave risk areas we used the following indices:

- Sky View Factor: mean value of the fraction of sky hemisphere visible from ground level.
- Built area Fraction: Ratio of building plan area to total ground area; fraction of ground surface with building cover.
- Building plan area: [m²] over Total ground area [m²]
- Impervious surface fraction: Ratio of unbuilt impervious plan area (paved, sealed) to total ground area.
- Street Incoming Solar Radiation: Kwh/m² >1 Potential solar incoming for street surface.
- Roofs Incoming Solar Radiation: Kwh/m² Potential solar incoming for roof surface.
- LST: Land Surface Temperature.

The indicator that characterised the adaptive capacity is:

- Pervious surface fraction

The analysis of climate and territory risks and vulnerabilities show the areas more vulnerable to heat waves. This enables us to identify the more critical zone where to localize NBS.

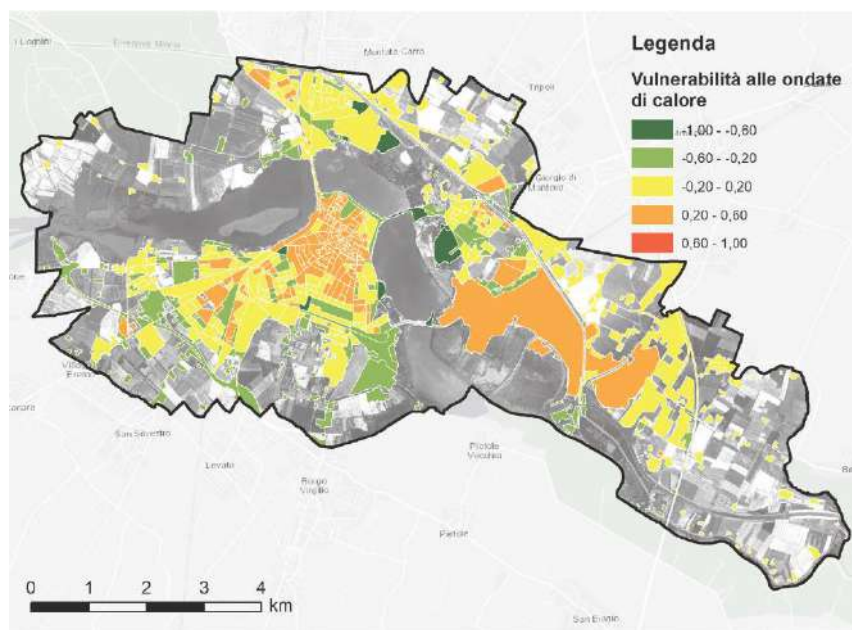


Figure 3.11: Vulnerability complex map

In the map above the value is the balance of all the morphologic indicators and a population indicator. In legend it can be seen the green colour for a low vulnerability and the red one for the highest vulnerability to heat waves.

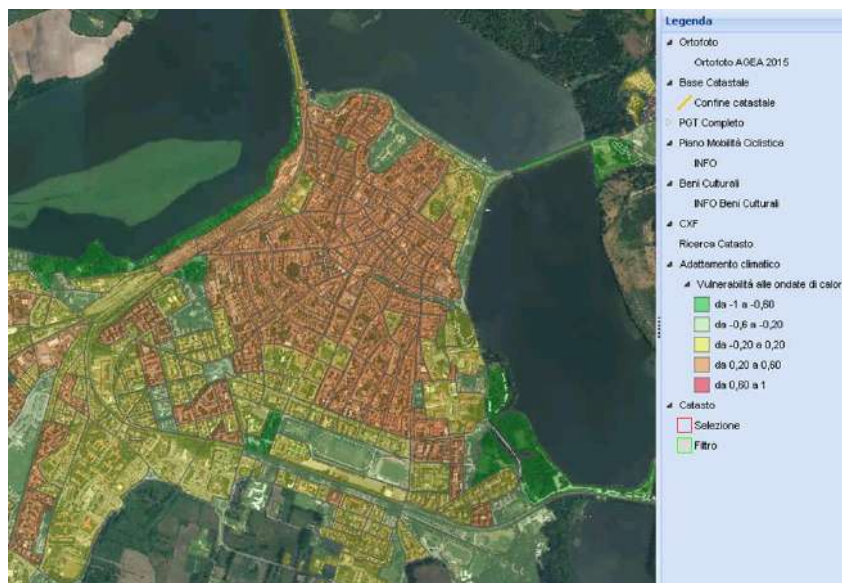


Figure 3.12: Vulnerability on heat waves

In summary, these analyses show that there are significant areas of the city with high heat vulnerability, including most of the historic centre, as well as the picture above and the industrial and commercial areas of the city.

3.3.2 Water management and flood risk

As already mentioned Mantova is a water city for the three lakes around city centre.

More than 8% of territory it is occupied by three lakes: the Lago Superiore (Lake Superior), the Lago di Mezzo (Middle Lake) and the Lago Inferiore (Lower Lake), and a wide wetland. The Mincio River catchment area is marked by the important reclamation and irrigation works carried out over the centuries.

The course of the river has today largely lost the meandering shape typical of the plains, due to subsequent control works that have rectified its course for long stretches, the construction of dams and reservoirs, from the hydraulic diversions that alter its flow in an artificial way with respect to seasonal trends.

The Diversivo di Mincio canal guarantees the hydraulic protection of the city of Mantova in the event of concomitant floods of Garda, Adige and Po, allowing to bypass the urban area of the capital city. Below the Diversivo flow the siphons allow the adductors of the left hydrographic to reach the Mincio. These contributions are very important for the oxygenation and hydrodynamics of the river.

Downstream of Lake Superior, the waters of the Mincio meet the barrier of the Ponte dei Mulini crossing it from the Vasarone regulatory building and from that of the Vasarina, used for the production of hydroelectric energy.

From Lake Superior, the inlet flows into Lake Di Mezzo and is regulated by Vasarone dam, to ensure a hydrometric level of 17.5 m upstream and 14.4 m for the Di Mezzo and Lower lakes.

The waters, in the Di Mezzo and Lower lakes, take on the character of lake basins and then, after passing the support of the Masetti dam, enter the Vallazza valley environment.

The following graph is a scheme of Mincio Basin, from Garda Lake to Po River.

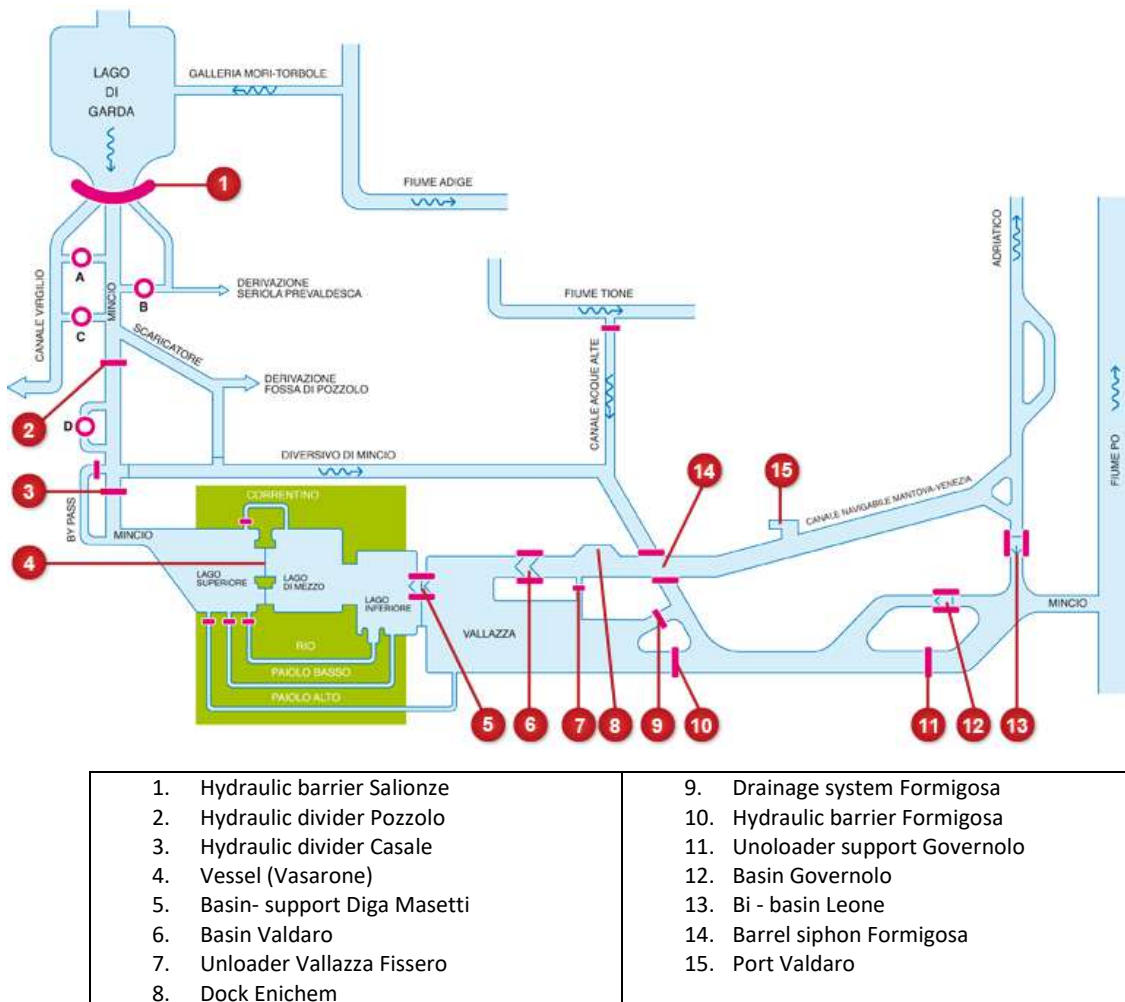


Figure 3.13: Scheme of Mincio Basin

The rainfall analysis shows that the climate is changing. Rainfall is becoming less frequent but more extreme. This poses the risk of increased flooding, including Combined Sewer Overflows in historic areas that have combined drains.

The graphs below show how annual days of extreme rain (R95P), and very rainy days (higher than 50mm - R50) are increasing, while maximum daily (RX1DAY) and five days (RX5DAY) precipitation is decreasing. This shows us how extremes are polarizing, leading to increasingly frequent and potentially dangerous extreme events for humans and harmful to infrastructures and agricultural and commercial activities.

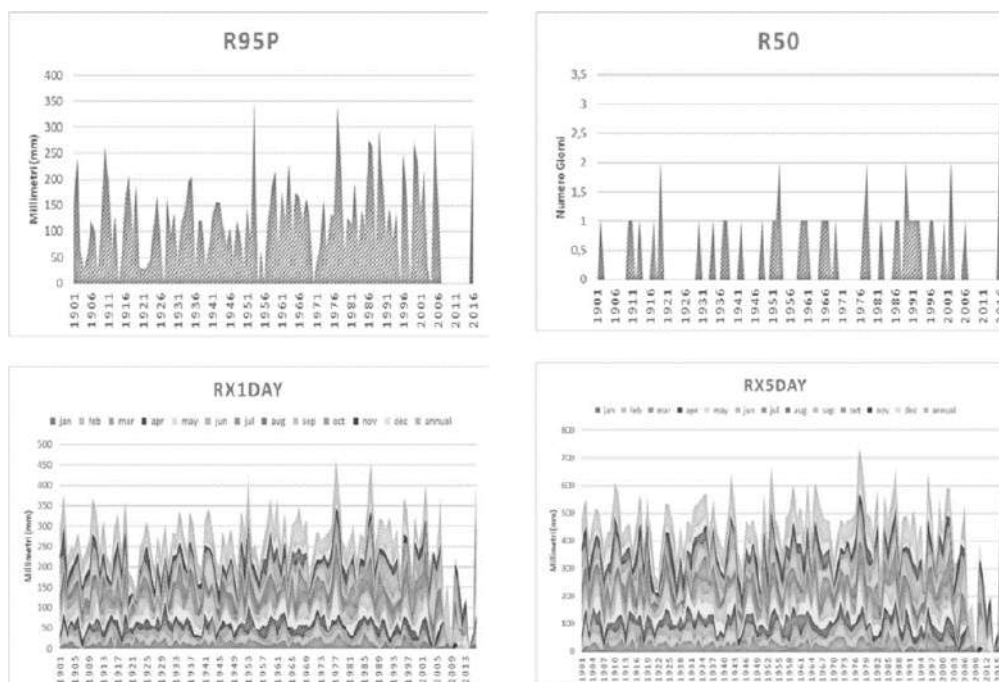


Figure 3.14: R95p - total amount of daily rainfall above 95th percentile during the year, expressed in millimetres; R50 - number of days in the year with precipitation of at least 50mm; RX1DAY - maximum daily precipitation; RX5DAY - maximum precipitation in 5 days.

This is one of the reasons that Mantova is working on a drainage and management water plan. The necessary activities for fulfilling the targets set out are all relating to define and quantify the flow rates transiting through the network for draining storm water and consequently define areas of intervention.

The necessary activities for fulfilling the targets set out are all relating to define and quantify the flow rates transiting through the network for draining the white waters.

Regarding water management system and run off in “Guidelines to increase Mantova resilience” there is a study focused on run off in different rainfall events (20 mm, 60 mm, 110 mm).

For evaluation of sensitivity, with respect to the increase in rain intensity and the possible impacts of urban flooding, the methodology involves the use of the Soil Conservation Service (USDA, 1972) model, developed by the United States Department of Agriculture. The model quantifies, by means of the evaluation of soil saturation, the quantity of water that, precipitating in the built environment, must be drained by the sewerage system. The approach consists in the evaluation, in relation to mm of rain that fell in a precise instant, the interception and infiltration carried out by the ecosystem services and determines the effective rain or direct runoff. The run off determines the different amount of rain that must be managed by the drainage infrastructures in the different areas.

The predisposition of soils to contribute to the formation of runoff essentially depends on two factors:

- characteristics of permeability of surface soils;

- vegetation cover and land use, which determined the value of the ecosystem services in favour of water lamination.

In the following scenarios the maps below show the vulnerability (respect all morphologic indicators and population) of the territory related to three different raining situation events. It is known in these cases where it is necessary to intervene. These maps show flood risk because they show what % of the water is running off (i.e. not being absorbed).

For examples in intense blue colour with a raining event of 20 mm we will have a run off risk between 80-100% in several areas of city centre.

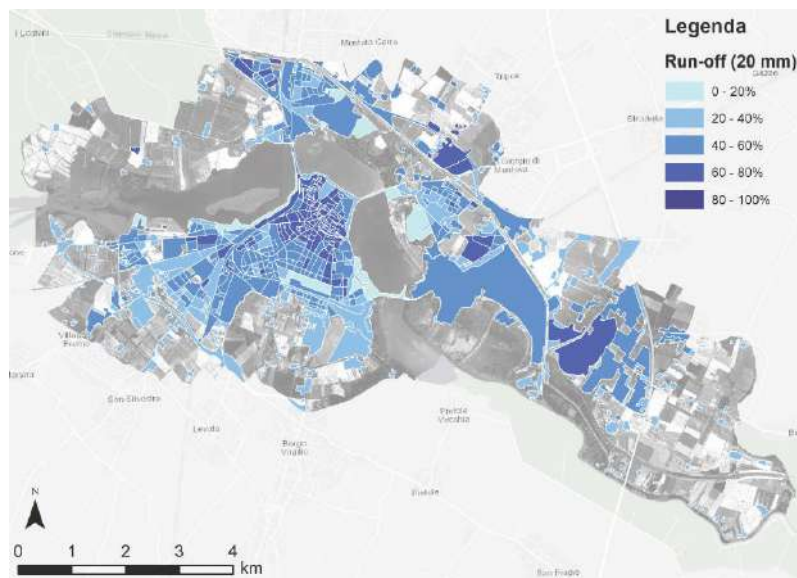


Figure 3.15: Run-off with 20 mm rain

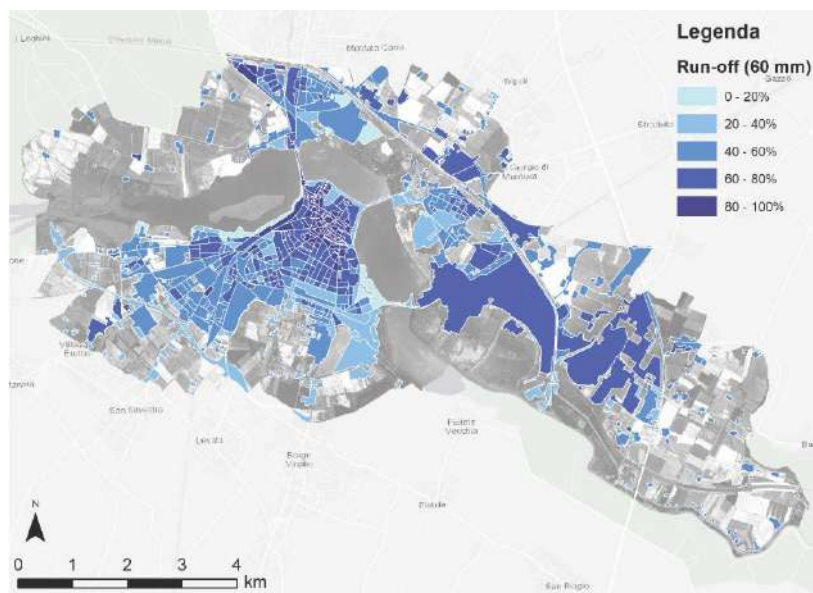


Figure 3.16: Run-off with 60 mm rain

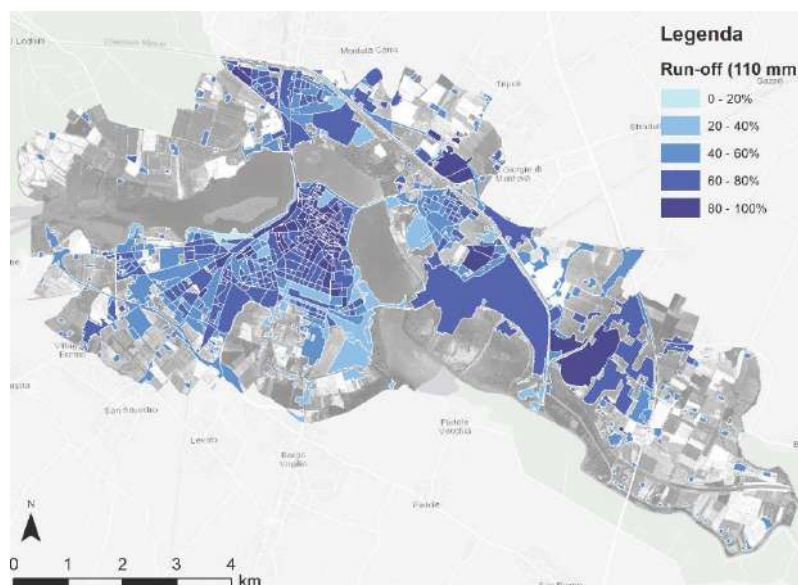


Figure 3.17: Run-off with 110 mm rain

The analysis of climate and territory risks and vulnerabilities show the areas more vulnerable to run off. As maps behind show run off risk is considerable in the central areas of the city characterize by higher impermeable surface cover.

NBS can be very effective in increasing permeable area to reduce run off, and prevent storm water reaching dangerous levels. This is desirable for Mantova. However, it is necessary to recognize that flooding is not the only water challenge in the city; in recent years it has seen periods of heavy rainfall, alternating with drought periods. This, in order to correctly manage water resources, irrigation of NBS in drought is certainly a factor to be taken into account for planning the maintenance of any NBS in the municipal area and for the management of related costs.

3.3.3 Air quality

Mantova is located in a densely urbanized lowland (declared by Environmental Ministry) and in its territory there is the presence of a chemical and industrial hub. The urbanized area is characterized by:

- Higher emission density of primary PM₁₀, NO_x and COV.
- Limited pollutant dispersion due to low wind speed, frequent cases of thermal inversion and long periods of stable high-pressure weather conditions.
- High population, industrial activity and traffic density.

All the air quality stations of the Province of Mantova seem to be in compliance with the legal limit on annual average, however in almost every station a number exceeding the daily average limit was detected higher than allowed in the standards. These exceedances of the daily average do not represent a unique critical issue for the Province of Mantova but more in general for the whole Po Valley, which includes other cities such as Milan, Turin, Brescia, and Verona.

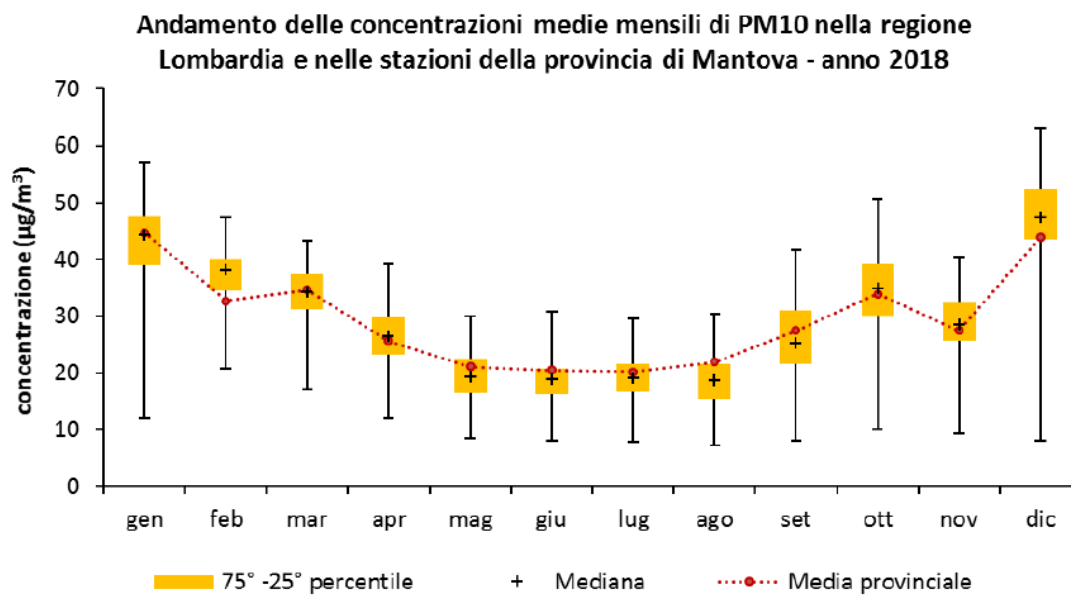


Figure 3.18: PM10 in 2018 in Mantova Province

In 2020 in Mantova concentration of PM10, 66 days were over medium of 50 mg/m³ in the worst city control unit.

3.4 Targets

3.4.1 Targets for Mantova

Respect the aspects described in the RUP it has been identified different target for each impact.

Flooding Target

- New study focused on water flooding risk. Comparison between impervious surfaces, main and secondary water network, sewerage system and rain water collection.
- Increase of pervious surfaces in urban area. Actions have been planned in parking areas and in historical city centre → **6000 m² of pervious surface in urban area**
- Decrease of water volume in sewerage system → **1000 m³/y**

Target for heat waves

- Increase city green belt multi functionality
- Increase green in urban area -- > **292 new trees by 2022**

Target for air quality

- Increase energy transition and energy efficiency of private buildings – **65% target reduction of CO₂ emissions before 2030**
- Increasing of e- bike use → **300 e-bike by 2023**
- Increasing of metre cycle pathways → **139,4 km (from Bicycle Mobility Plan)**
- Increasing of ride and park areas outside city centre → **2**

3.4.2 Existing achievements

Substantial NBS delivery have been already achieved in and around Mantova.

FORMIGOSA – URBAN FORESTRY



In the winter of 2018-2019, the Municipality launched a project called "New green infrastructures in the Municipality of Mantova: Left Bank Lower Lake and Formigosa wood", with an amount of 438,000.00 euros financed mostly by the Lombardy Region. The project involves the establishment of new woods around the small town of Formigosa and the construction of a small wooded area, and develops it in a linear fashion along the shore of the Lower Lake. The total area of intervention is 5.5 hectares, with the use of 7,000 forest plants as well as 100 ready-to-use trees. The intervention, successful and subject to ordinary maintenance, is confirming the great value of forest plants for environmental purposes.

Challenges: **Heat Waves, Air Pollution**, Public Health and Well-being, Potential of economic opportunities and green jobs

NBS: PERI-URBAN Forestry/green Belt

Functions:

- 1) Air quality maintenance
- 2) Climate regulation
- 3) Recreation and eco-tourism

PIAZZA ALBERTI – HISTORICAL CITY

Before



After



On the west side of the square, towards Vicolo Nazione, a tree-lined space has been created for people to stop. In the shade of 8 trees (especially *Parrotia persica*), there are benches that replace the previous parking destination.

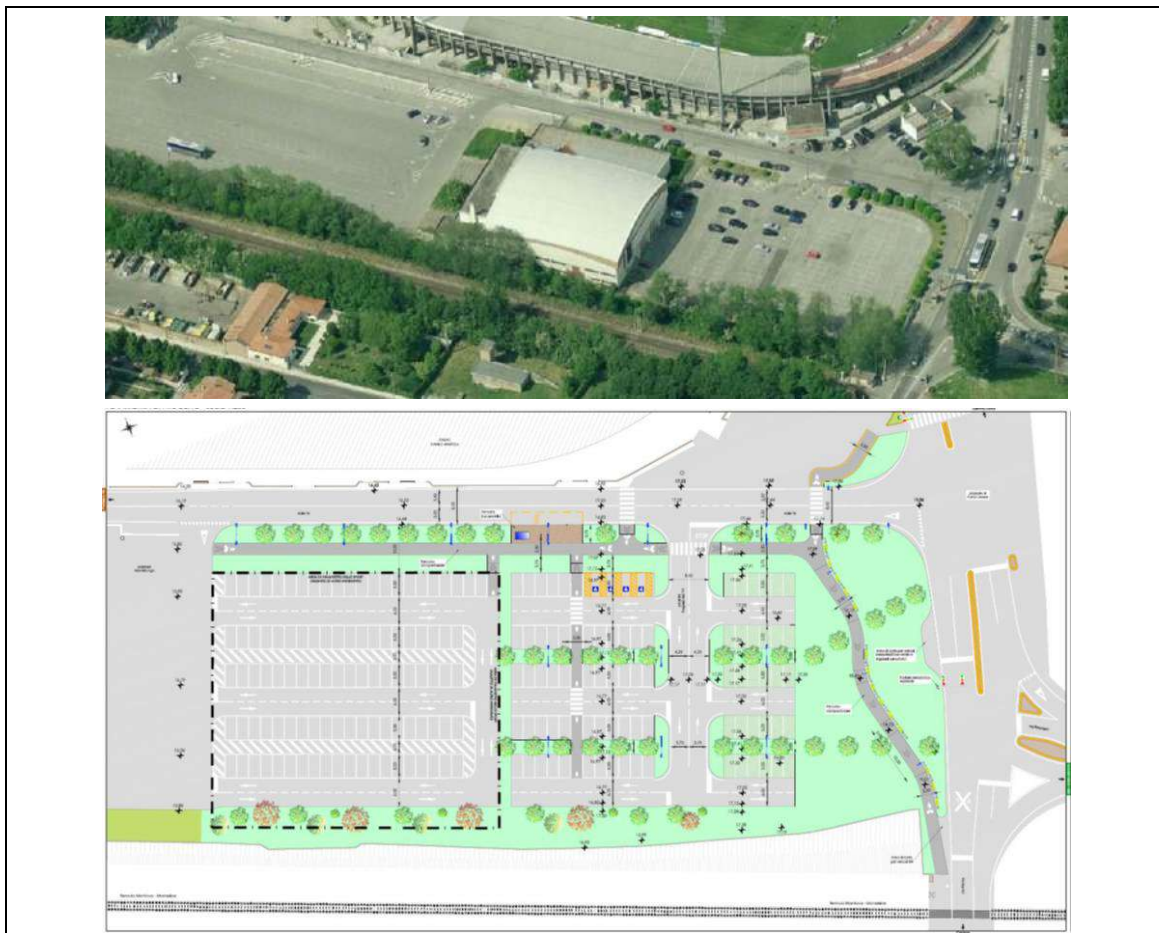
Challenges: **Heat Waves**

NBS: Urban Trees

Functions:

- 1) Climate Regulation
- 2) Inspiration
- 3) Aesthetic values
- 4) Social relations

FREE PARK AND RIDE AREA IN "PIAZZALE MONTELUNGO"



Piazzale Montelungo is a paved asphalt area for parking use. It is becoming a resilient park and ride area according to the PUMS (Sustainability Urban Mobility Plan). It is located next to the railway line, in continuity with the recent parking Piazzale Ragazzi of '99, until it reaches the building of the Bocciofila; inserted in the context of the municipal stadium and the green area used as park of Palazzo Te. The total area is about 8,000 m².

The aim is increasing parking areas, outside the city, in order to limit parking search and consequently the rise of emissions into the atmosphere.

Increasing of green in this impervious area.

Challenges: **Heat Waves, Run Off, Air Pollution**

NBS: Urban Trees

Functions:

- 1) Air quality maintenance
- 2) Climate regulation
- 3) Water regulation
- 4) Aesthetic values

GREEN AREA - PONTE ROSSO

Before

After



In spring 2017, over 300 new trees and shrubs were planted in the Ponte Rosso district, using an area next to the railway line, previously paved. This operation created a green belt between the town and the railway. Now there is a new public garden, with trees and internal roads, a football and basketball pitch.

Challenges: Heat Waves, Run Off, Air Pollution

NBS: Urban Trees

Functions:

- 1) Air quality maintenance
- 2) Climate regulation
- 3) Water regulation
- 4) Aesthetic values

CAMPO CANOA - FREE PARK AND RIDE





The new park-and-ride at Campo Canoa has a number of features:

- *Strategic filter area* between the monumental zone and the environmental lake areas, directly involved in the lake environmental system and in the programs linked to the tourist use of the historical-artistic heritage of the city.
- *Replacement and integration of new trees* in the green areas around the car park, using *native species* to mitigate the visual impact of the parking area and *improving the specific endowment of the plant species* in the area.
- *Grid recyclable draining plastic floor* guarantees the preservation of high soil permeability levels, removing the need of rainwater collection systems, which will therefore remain unchanged.
- The lanes and the access road to the area will be made of *low impact floor in light colour*, in keeping with the context, consisting of a finishing layer made of a mixture of transparent binder and crushed stone such as 'COLOR BIT' (Water-based coloured protective for bituminous membranes)
- Species used belong to the local flora and are able to adapt to the edaphic situations and the landscape in which they are located.

Challenges: **Heat waves, Air pollution**, Public Health and Well-being

NBS: Green Parking pavements, Urban Trees

Functions:

- 1) Air quality maintenance
- 2) Climate regulation
- 3) Pollinator (selection species)
- 4) Aesthetic values

BEE Hotel in Lungolago Gonzaga



This intervention seeks to provide bee habitat in an urban part of the city. The module is suitable for areas without availability of natural soil in order to create new habitats for a diverse wildlife of pollinators in cities.

These modules are designed to attract pollinators and biodiversity in general by weather conditions (colder areas in hot periods and refuge for wintertime) and feeding (water and food providing areas for pollinators). There are food and refuge providers.

It will have both biodiversity and an awareness element for citizens.

Challenges: Air quality, biodiversity, climate change mitigation and adaptation, green space management, urban regeneration

NBS: Pollinator modules

Functions:

- 1) Air quality indicator
- 2) Education
- 3) Pollinator (selection species)

Cycle and pedestrian NBS pathway in Fiera Catena



This cycle pathway completes existing cycle paths on lake sides and the ones which connect neighbouring municipalities where Mantova opened the new cycle path on Fiera Catena bridge and Anconetta neighbourhood.

The intervention involves the recovery of the existing bank road, named Vicolo Maestro, with road paving in draining materials.

It is characterized by pathways that provide recreational, public health and well-being opportunities, as well as transportation linkages. It serves to connect cyclists and pedestrians to

| |
|---|
| nature. In this sense, this cycle and pedestrian green route combine a range of benefits such as: <ul style="list-style-type: none"> • Improve bicycle and pedestrian transportation • Improve public health through active living • Enhance cultural awareness and community identity |
| Challenges: Air quality, public health, climate change mitigation and adaptation, green space management, urban regeneration |
| NBS: Cycle and pedestrian green route |
| Functions: <ol style="list-style-type: none"> 1) Air quality 2) education 3) Urban regeneration |

3.4.3 Existing Policy and activities

The CLIMA (Climate) strategy is the ecological transition policy for the city's ZERO Carbon target. In this context there is Mantova's RUP and there will be work in a transversal and interconnected way, in order to immediately consider possible alternatives and trade-offs. Thanks to the knowledge gained through the analysis of Mantova's challenges, the construction of a climate transition strategy that must interact with a number of existing policies that also relate to NBS can be approach. These are outlined below.

Climate adaptation guidelines

Mantova has good information about actual climate situation and risk. But there is uncertainty about the timing and intensity of the expected change, so it is necessary to use monitoring system in order to adapt and update knowledge. In the guidelines there is a catalogue of suggested solutions for a specific context of the city, focused on different and specific situations such as flooding, heat waves, pollution risks (urban, residential, industrial, commercial, agricultural areas) linked to different impacts. NBS are solutions that can be found in the catalogue such as rain gardens, green roofs, pervious soils etc.

General Urban Plan

General Urban Plan is the main Municipal tool that governs the development of Mantova. RUP will be integrated in this instrument, and it will be monitored, in General Urban Plan monitoring, every year from local Municipal departments.



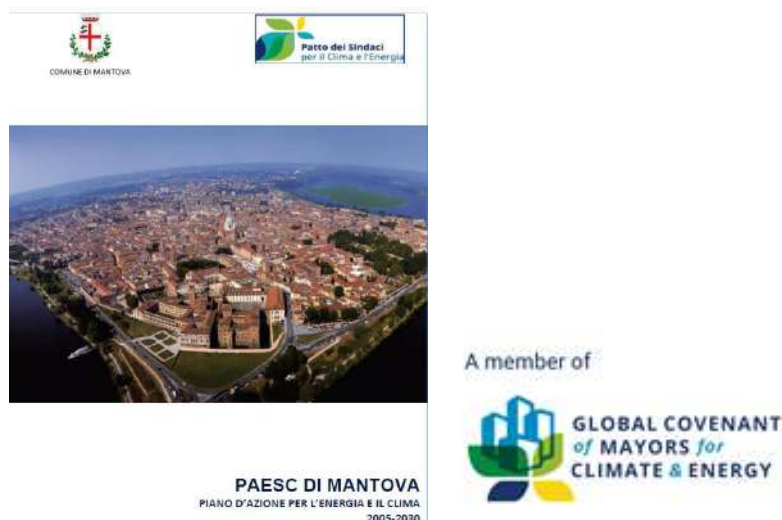
SECAP (Sustainable Environmental Climate and Adaptation Plan)

Figure 3.19: The PAESC of Mantova

In February 2019 Mantova signed Covenant of Mayors EU and in July 2020 approved the Sustainable Environmental Climate and Adaptation Plan in July 2020 with a 65% CO₂ target reduction before 2030.

In SECAP, based on Climate adaptation guidelines, actions are outlined to face climate change and to increase territory resilience. NBS implementation is one of these actions and stakeholder involvement is the core approach to transition. In June 2019 the Municipal City Council approved Environmental and Climate Emergency Declaration to enforce its commitment against climate change.

UNESCO Management plan

Climate adaptation has been included as an integral part of UNESCO Management Plan. This shows a new intersectoral and multilevel approach in city vision. Given that the old centre was protected under the UNESCO management plan, the management or any implementation of the NBS response or intervention has to consider the fact that the old centre is under two different management systems and requires higher attention regarding which responses are selected for the site (such as in response for heat island effect).

Mantova Challenge

After 1° World Forum on Urban Forestry organized by FAO in Mantova in 2018, Municipality of Mantova signed the Mantova Challenge and created a local Tree Board. The aim of Tree Board group is to increase urban forestry and citizen awareness about the role of greening in a resilient and sustainable city. This approach is coherent with NBS use also in private areas.

In Mantova the Tree Board office is coordinated by the referent of the public green service and foresees the involvement of several sectors of the municipality in order to effectively pursue the objectives of urban forestry.

Mincio River Contract

A positive feature for the implementation of NBS is the participation of the Municipality of Mantova in the Mincio River Contract. The goals of the contract are to improve quality of water and territory in the Mincio basin and to reach an optimal management of water. This tool can contribute to the replication of NBS on a wider territorial scale, which the Municipality of Mantova will also benefit from. It also provides a good basis for collaboration with other municipalities to tackle challenges that are of a larger scale than just our city.

Sustainability Projects

Many actions and activities about sustainability, urban regeneration, sustainable mobility, awareness of climate change, ecotourism, green in general are developing during this period. Some examples include:

- shared mobility, e-mobility and cycle pathways
- communication of climate change themes in cultural events
- NBS for urban regeneration

A large number of different stakeholders are involved in these projects and in the activities. The local stakeholders have a significant role in climate change strategy of Mantova.

Water Plan

Municipality of Mantova launched a study path to understand the problems and face the risks associated to the issue of hydraulic risk.

At first, it was focused on water grid system, main pipes of the municipal network for white and mixed water, of the principal privately owned ditches. Then it was studied the principal sewerages serving the urbanized areas and of the principal privately owned ditches which affect more strongly the public network and therefore are of public interest.

The purpose of this study is the identification of the areas next to every canal stretch or storm drains defining the principal hydraulic parameter and a construction of a hydraulic model to identify the principal hydraulic critical issues due to run-off difficulties for deficiencies in the network.

Linked to this study is the natural water network and its critical issues. The complex water plan must consider both studies in order to identify the right measures for solving the hydraulic critical issues.

In next months, Municipality will define an overall thematic study, in order to identify local solutions and “guidelines for the Municipality” for planning and construction of new buildings in order to define solution for local water plan. This new study will be financed by Foundation Cariplo project – ACE3T.



3.5 NBS Actions

Mantova is committed to using NBS to respond to the challenges of heat, flooding and air quality, while also offering co-benefits to many other challenges in the city, like noise, carbon emissions and water quality.

To achieve Mantova's goals, it is not possible to act only on land controlled by the Municipality. It is also needed to work with private property owners at strategic sites, and modify the systems of planning to encourage developments that integrate NBS.

Accordingly, this section first discusses a series of direct actions in which NBS will be created in existing planned projects on public and private land, and then secondly regulatory changes to ensure that NBS are implemented as the city grows.

3.5.1 Direct actions

As regards the actions aimed primarily at adaptation, both urban and peri-urban forestry interventions are envisaged with the multiple function of improving the urban microclimate, air quality and reducing the risk due to the formation of heat islands, to filter pollutants and noise, to favour biodiversity, to improve soils stability and quality, but also water infiltration during meteoric events. The forestation and NBS introduction will be planned paying particular attention to the multifunctionality of these areas through the choice of tree and shrub species, their arrangement also through the introduction of innovative natural and technological solutions, and also considering their possible use.

In this perspective, agricultural areas will also be rethought and redesigned through the introduction of hedges / rows / buffer strips in order to protect water bodies, mitigate the effects of run-off in the event of extreme events, protect crops and improve the quality of soils. Thanks to regional economic support it will start waterproof surface removing and new green spaces introduction in Montelungo parking, as already done in Campo Caona Parking.

NBS use will be very important, especially in urbanized areas, in order to reduce and mitigate the impacts of localized flooding and heat islands. As a complement to the introduction of NBS, engineering interventions are also planned aimed at reducing hydraulic risks and improving the hydraulic and ecological regime of the Mincio Valleys, such as the requalification and technological adaptation of water bodies. It has been identified a number of five specific project sites for NBS delivery, as mapped in Figure 3.20. Below, it is provided detailed analysis for two largest projects (BOMA and Palazzo Te) and a short overview of the other three sites.



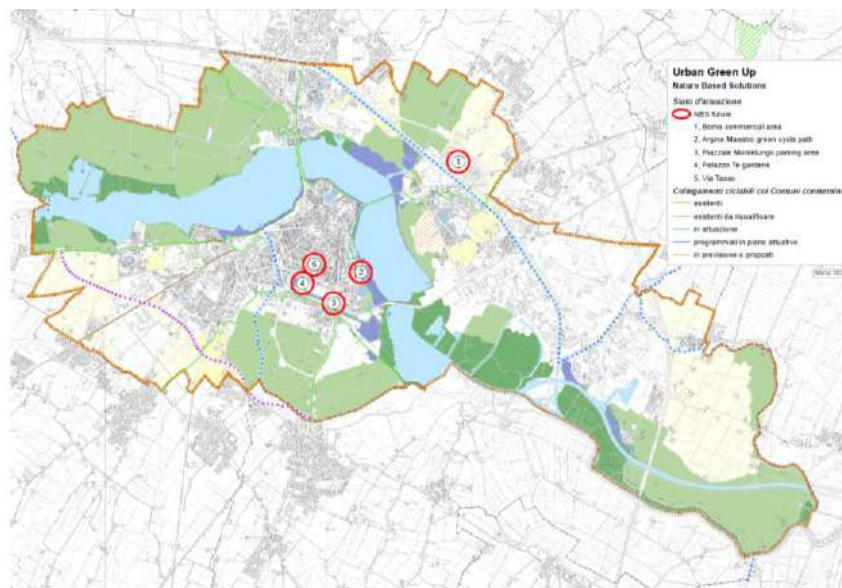
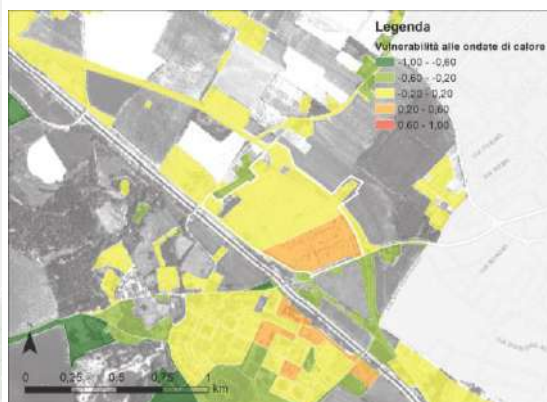


Figure 3.20: Localization of Nature-based Solutions in Mantova

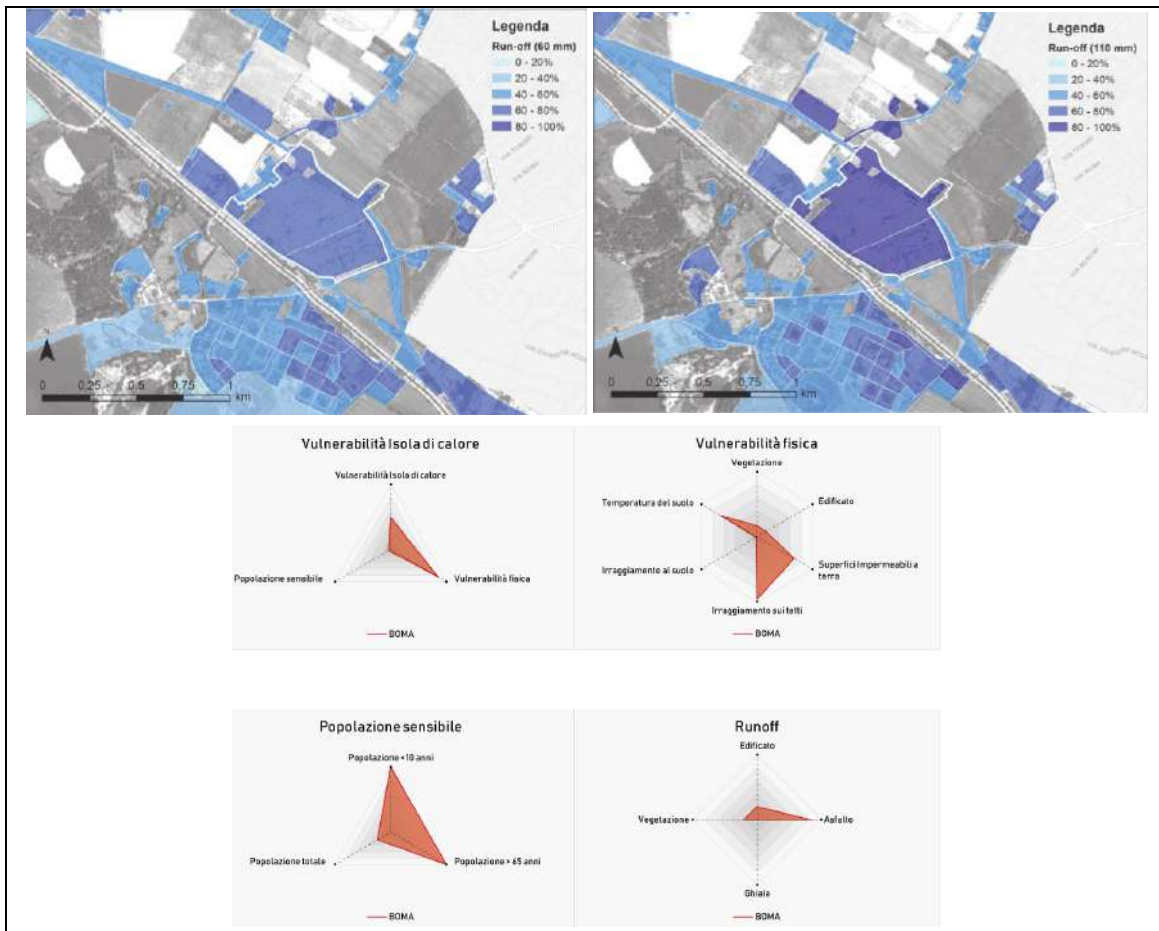
3.5.1.1 Greening the BOMA commercial area

2 COMMERCIAL AREA - BOMA

Before



Heat Weaves



The Commercial Area Boma fits into an extremely urbanized and mainly fabric intended for tertiary functions. Located north-east of the historic centre it is presented as a node of the commercial and tertiary economic system of the Municipality of Mantova and Mantova Province.

The area is characterized by a system of shopping centres and parking areas and a system of office buildings. Morphologically it is detectable the almost absolute absence of trees or green surfaces and the material mainly used for the road axes is the traditional dark asphalt.

Challenges: Run off, Air pollutions

NBS: TO SELECT

Trees renaturing parking

Green parking pavements

Additional NBS from catalogue (subject to design)

Functions:


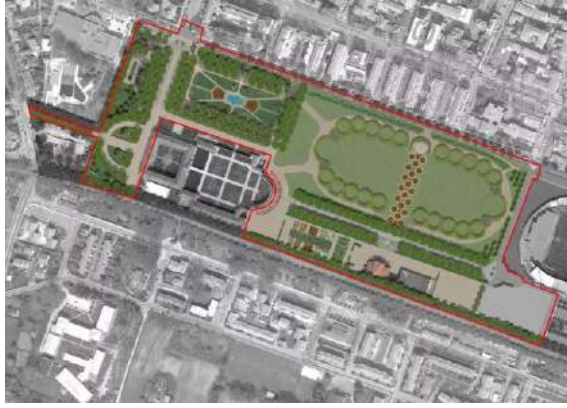



- 1) Air quality maintenance
- 2) Climate regulation
- 3) Water regulation
- 4) Aesthetic values
- 5) Pollinator (selection species)

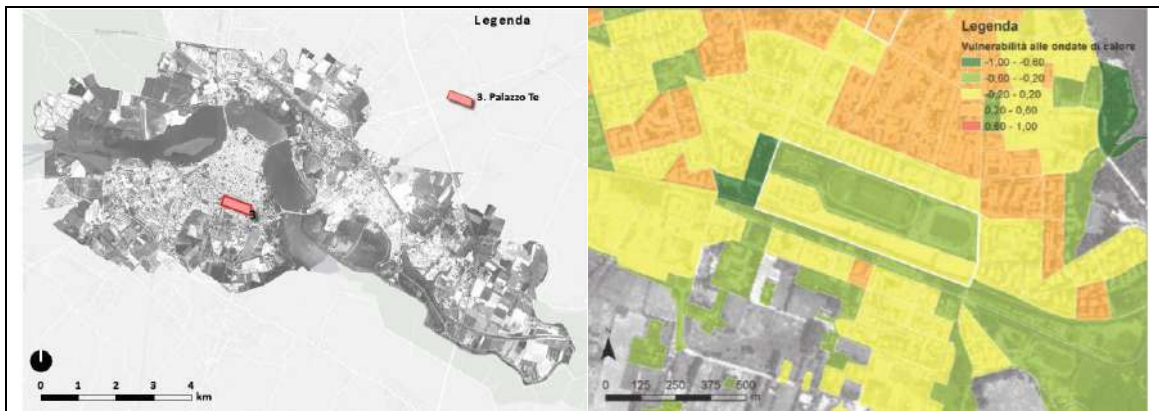


6) Inspiration

3.5.1.2 Palazzo Te garden area

PALAZZO TE - GARDEN

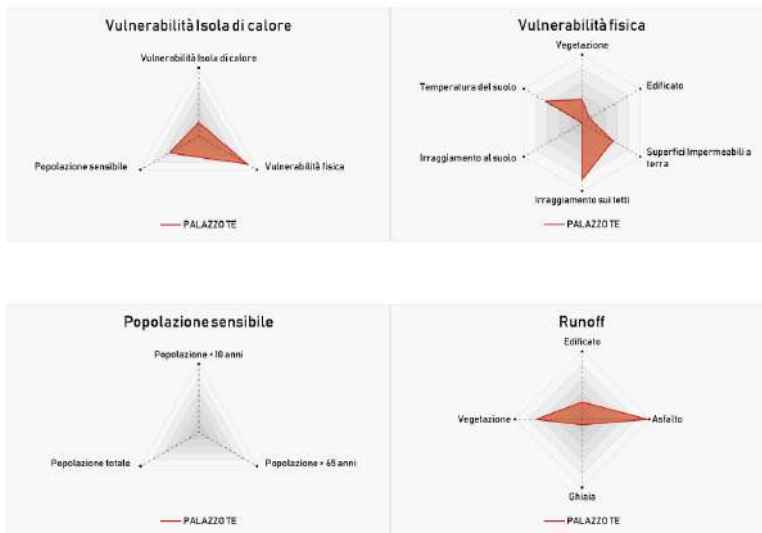
| | |
|--|--|
| Current | Proposed |
|  |  |
| Current | Proposed |
|  |  |
| | Proposed |
| |  |



Heat waves vulnerability



Run off in case of 60 mm rain and 110 mm rain



The area close to Palazzo Te is located in the South of Mantova historic centre and is one of main monument of UNESCO Site. The area is composed By Palazzo Te and its park, the sports field of the city, the stadium and a large parking is currently outlined as one of the city gates. The neighbouring areas are dense and residential.

Palazzo Te should be highlighted for its morphology and function. The area presents itself characterized by a system of green areas and empty or parking areas, which they should manage different uses and functions, from the courtly entrance to the city that frames Palazzo

| |
|---|
| Te, the recreational sports area and the empty space for the amusement park and fairs. |
| Challenges: Run Off, Air Pollution |
| NBS: Shade trees, Cycle and pedestrian green paths, Renewal urban trees |
| <p>Functions:</p> <ol style="list-style-type: none"> 1) Air quality maintenance 2) Climate regulation 3) Water regulation 4) Aesthetic values 5) Pollinator (selection species) 6) Inspiration 7) Social relations |

3.5.1.3 Piazzale Montelungo – Shade trees, pollinator modules and raingardens

As noted in the ‘existing achievements’ section, this area has already received upgrades as part of the PUMS to become a park and ride (Sustainability Urban Mobility Plan). Further NBS upgrades are planned, including creation of flowerbeds in rows, consisting of lawn and trees, among which continue to ensure the rest, alternating with small areas completely unpaved and planted with trees and lawn, shaped as a swale to contain the collection and drainage on site of storm water.



Figure 3.21: Proposal for Piazzale Montelungo

3.5.1.4 Greening Cycle Route “Argine Maestro”

As part of the commitment to reducing emissions from Mantova, the focus is on interventions to enhance the cycling and slow mobility systems of the territory with actions aimed at increasing their resilience through innovative solutions, often including NBS (e.g. Cool pavements, draining pavements, shaded rest points, etc.).

In the specific case of Argine Maestro, NBS will be implemented to encourage a Green Cycle Route. It is intended to plant a double row of trees surrounded by a cycle and pedestrian path that on the southern eaves of the city connects the city's cycle paths with the main guidelines of regional and national interest, as well as representing a well-established path for the achievement of the lakeside and for the recreational activities of the inhabitants or proximity tourism.

Embankment cycling path, with orientation about northwest-southeast, paved with draining concrete and equipped with lighting system on one side, poor soil quality.

3.5.1.5 Via Tasso – Cooling trees and parklets

Via Tasso is a pedestrian area of the old town paved in asphalt, located between an elementary school and a technical institute. The area is about 1,000 m².

Planned interventions include the formation of permeable flowerbeds, with shading function and furniture, interspersed with benches, bicycle rack and urban furniture.



Figure 3.22: View of the current situation of Via Tasso

3.5.2 Regulatory changes to promote NBS

3.5.2.1 Updating Mantova's General Urban Plan (PGT)

In order to integrate climate mitigation and adaptation issues in an integrated way within the management and design activities of the municipality, the revision of urban planning tools and territorial governance plans is envisaged. Specifically, the revision of the General Urban Plan is envisaged through the inclusion of measures and standards in the Rules' Plan and in the Services Plan. If all those measures are inserted systematically in the planning phases of the urban and rural territory, can mitigate the impacts of climate change, such as the colouring and permeability of pavements, the presence of greenery in certain circumstances (such as Via Tasso and Vicolo Maestro project), energy efficiency and water recovery when possible.

Furthermore, given the conformation of the territory and the criticalities highlighted, a study path and subsequent revision of the tools will be launched in relation to the flood risk that has increased in recent years due to climate change. The increased risks caused by localized flooding, due to the change in the rainfall regime, require a reinterpretation of the entire water network in a resilient plan capable of reconciling and harmonizing both natural interventions (green & blue infrastructure) and traditional engineered interventions (grey infrastructure).

Specifically, the actions considered are:

1. Revision of urban and non-urban planning tools, through the inclusion of RUP and policies aimed at mitigating and adapting climate change. Climate governance included in the PGT and in particular in the Rules Plan and in the Service Plan.
2. Adaptation strategy related to the flood risk issue for the municipality of Mantova. Integration in a single reading of the hydraulic criticalities of the territory by systematizing and comparing the information collected to fully define the necessary interventions aimed at minimizing risks and inconveniences on the territory, with a view to long-term solutions and adaptation to climate change. These will specifically consider NBS as part of a modern approach to flood management.

The new planning regional instrument, under development, proposes the introduction in municipal regulations for building of specific rules to increase resilience, such as NBS and innovative technology in the transformation of urban areas.



3.6 Roles and responsibilities

3.6.1 Organization

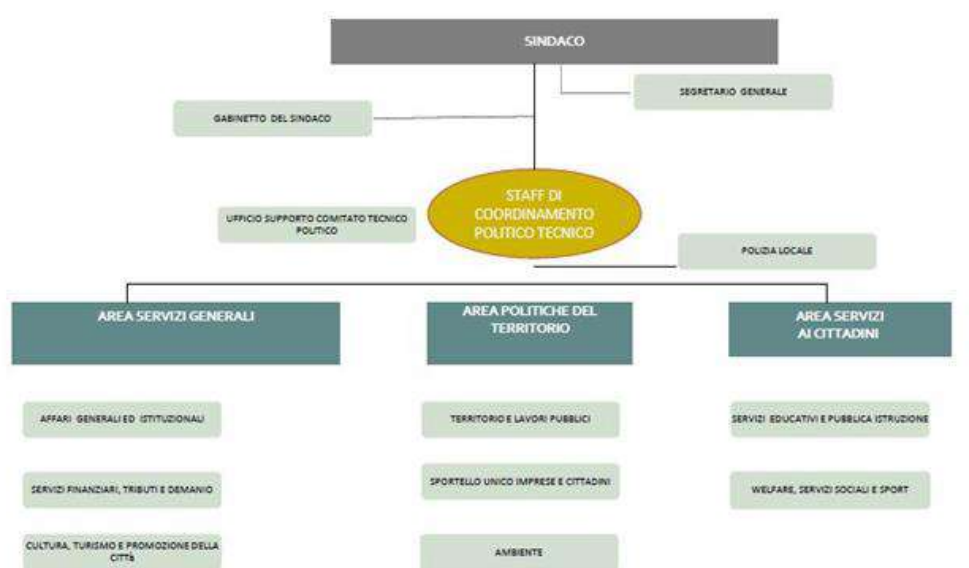


Figure 3.23: Diagram of the roles and responsibilities organization

The main role and responsibility about internal municipality stakeholders is in the territorial policy area, which governs land use. The municipality is subdivided in three different departments:

- General services (finance, institutional affairs, tourism and culture)
- Territorial policy (public works, environment, sustainable mobility, citizens front office)
- Citizens services (school and welfare)

The municipal departments directly involved in RUP creation and implementation are planning offices, civil works, environment and culture.

In last months, in the main strategy of the municipality there is also a transversal and synergetic strategy for the organization and the activation of the actions that are coherent with Agenda 2030 and its goals. All the sectors of the municipality are working on monitoring and alignment of the activities on municipal territory linked to SDGs.

3.6.2 Local communication and dissemination

The first major event in which URBAN GreenUP project and the aims of the project were promoted was the event organized by the Municipality of Mantova and FAO on urban forestry in 2018.

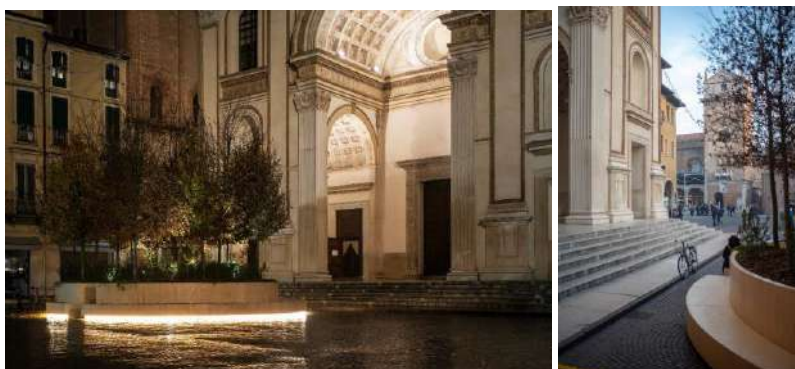


Figure 3.24: Photo by Openfabric during FAO Event in 2018

But there are other events where URBAN GreenUP and RUP can be promoted.

In Mantova City Council there is a specific transversal office called Tree Board. The activities of this office are directly linked with RUP activities. In this context, the RUP will be applied, developed and promoted with NBS in the city.

There will be a specific website with all information about the green in the city and its ecosystem benefits. The website is studied in particular for communicate to the people the benefit of a green area in urban context. The green website will be launched in Summer 2021.

Mantova City Council is also working in an European project URBACT C-Change regarding the climate change and culture. Many cultural associations are involved in the promotion of NBS, such as forestation in urban areas, compensation and more in general in the promotion of resilience actions against climate change.

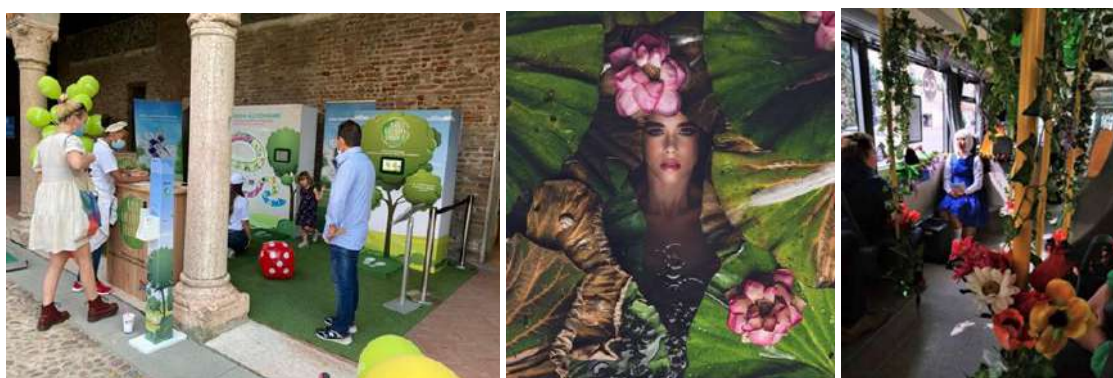


Figure 3.25: Participation of Mantova City Council in URBACT C-Change

Moreover, there is a specific national day, in November, in which trees are celebrated and during this event there will be promoted NBS and RUP.

3.6.3 The role of stakeholders in the development of next General Urban Plan

Consistent with the European and national regulations relating to the Strategic Environmental Assessment (SEA) of Plans and Programs, this procedure is also envisaged as part of the revision of the urban planning instrument for governing the territory. Specifically, the SEA procedure will be open to all stakeholders in the area and will follow the development of the plan from its initial construction phase.

The construction of the RUP has its roots in the participatory process that accompanied the construction of the Mantova Climate Adaptation Guidelines.

There were numerous meetings with stakeholders of the territory and with official Bodies in order to understand the criticalities of the territory with respect to the issue of climate change, in particular for a particular city like Mantova (natural areas, UNESCO site, polluted).

Therefore, without prejudice to the knowledge acquired also by the Stakeholders, their direct involvement will start again in the context of the revision of the general municipal planning tool.

During the development of General Urban Plan there will be a participatory co-creation processes and a review of the internal and external groups of stakeholders and the main role and responsibilities in the development of RUP.

The involvement of stakeholders in choosing future is particularly strategic for Mantova. It is necessary to continue a participatory process in resilience and mitigation strategy. All the citizen, stakeholders, institutional bodies will be involved in this urgent changing process. At first it is necessary to create awareness and knowledge. Everybody must be informed about climate change impacts, energy efficiency and real actions that help to contribute to the changing.

The engagement strategy will be:

- To promote meetings with principal stakeholders of the territory and collect more detailed information on specific needs
- To promote meetings in the schools involving teachers and families also with a specific information booklet
- To promote meetings with citizen and environmental associations
- To promote meetings with institutional bodies (local, regional level)
- To organize an inter-sectoral municipal working table (Environment, Public Works, Civil protection, Mobility and Transport, Green office, Budget office) and neighbouring municipalities of Great Mantova to propose common projects and actions

The diffusion of the awareness of NBS and of the resilience actions that can be implemented is necessary for the diffusion and replication in different context.



3.7 Processes and Reforms

3.7.1 Accessing Finance

In the implementation and up-scaling of Nature-based Solutions (NBS) through the development of RUPs as tools for climate change mitigation and adaption there are a broad range of potential barriers and boundaries: Political, Technical, Legal/Organizational, Social/Cultural and Financial. Here it is summarised some of the key barriers that the RUP will face, and discuss how these can be managed to successfully deliver NBS.

European, National and local governments are the most common funding source for urban greening projects at municipal level, but they are not the only option. A different and growing range of underutilized solutions are proving increasingly useful to reduce cities' reliance on public funding.

Horizon 2020, LIFE + CLIMATE ACTIONS, INTERREG, FEASR are the principal European founding source. Of course, it is also necessary to collaborate with other public bodies and private companies. At local level Municipality of Mantova has a specific European office deputy to find financing opportunities. The office works at local level with European office of Mantova's Province. The Municipality of Mantova has a specific annual budget dedicated to green management.

At regional level there are different funding opportunity not only from the Region (Lombardy) but also from foundations such as Fondazione Cariplo in Lombardy or Cariverona in Veneto Region. In the last years greening and resilience are one of the subjects financed.

There are other forms of funding opportunities such as:

1. Innovative use of public budgets: cities can pool resources from different government departments and access previously untapped sources, such as public health or education budgets, to achieve joint goals within the municipal administration.
2. Engaging with social investors and the private sector: not only considering financial aspects but also social benefits. Social investors can be good funding partners of NBS projects with financial returns below standard commercial yields, increasing the quality of life, well-being, health and community cohesion. Currently, we are working on a Climate adaptation strategy financed by Cariplo Foundation and we await the outcome of other applications focused in city green belt and water system. As part of the project funded by the Cariplo Foundation, there is also a dedicated Capacity Building program that will train the project partners with respect to issues related to the issue of resilience and mitigation, providing together with this also support for the application for tenders.
3. Support citizen crowdfunding. The experiences of associations that intend to operate in the field of urban forestry multiply and raise funds through web network. For example, the local R84 association intervenes on some areas of the left bank of the lower lake with forestation and fruition objectives.



4. Using green finance and debt instruments: the banking sector and insurance companies represent opportunities for engagement due to their exposure to climate risks. Financial institutions can offer loans and help public companies and utilities launch their own green bonds.

3.7.2 Accessing land for NBS

In future, to source funding for NBS, the priority approaches to be leveraged will be participation in European, National or Regional calls.

The main challenge that Italian municipalities face in increasing Nature-based Solutions, or technical solutions, is the availability of public land. Municipality of Mantova does not always own or have legal access to the land that may be suitable for Nature-based Solutions.

To manage this challenge Municipality will take three approaches.

The first one is to participate in calls for loans that allow the purchase of land. An example of these formulas of actions is the participation in the Regional Green Systems Call, financed by Lombardy Region, which has made it possible to create the Bosco di Formigosa in recent years, which has seen the purchase of new areas available for planting new trees and new applications for projects that see the involvement of private entities and associations (Es Bando Cariverona, new Bando Sistemi Verdi).

The second option is to initiate partnerships with the private sector both in terms of associations that promote environmental initiatives, and of companies that intend to mitigate their impact on the territory with forestation and mitigation interventions.

A third possibility for the public administration is to intervene on existing public areas with specific de-pavement action and urban forestation.

In all cases, the interventions implemented directly by the Municipality are included in the municipal budget, even in the case of funding deriving from tenders that are registered by the body as economic revenue. Such natural solutions are planned in some areas of the city and will be enhanced in the near future. Examples include the Via Tasso and Montelungo projects.

3.7.3 Heritage restrictions

There are also a lot of architectural constraints and height restrictions especially in the UNESCO World Heritage parts of the city. This is a real limit to the introduction of innovative solutions, both natural or technical. On the other hand, the legislation supporting energy transition and climate change action is very recent and often not yet applied. At regional scale, for example, it is supported the use of greening to reduce summer heat waves in urban areas, but there is not a specific rule about this.

In this context, it should also be remembered that the issue of energy efficiency must comply with national regulatory guidelines and that no obligations can be introduced at the municipal level, but only incentive forms, which are difficult to apply in the case of buildings and restricted areas.



At regional level, the goal is to introduce emission mitigation and reduction criteria wherever possible, favouring the increase of urban green spaces and innovative technological solutions, while respecting the landscape and architectural values of the context. To date, any transformation in a restricted area must be subject to landscape authorization, in compliance with current legislation.

In SECAP (Sustainable Energy and Climate Action Plan) context, the Municipality of Mantova has nevertheless approved the commitment to activate a proactive dialogue with the competent office for cultural buildings in order to agree a shared path to facilitate the energy efficiency of the buildings also in the context of the restricted areas. Discussion of NBS could form part of these negotiations.

3.7.4 Aligning our organisation to deliver new NBS

NBS and resilience are new important themes for all public bodies and people. All new territorial planning and programming tools at all scales (including regional and national) provide a focus on this theme.

Works have been done closely within the municipality to bring all teams into alignment. Works will continue with other agencies and with private owners in developing new strategies oriented to resilience. However, the path activated up to now has shown an increased sensitivity to the use of NBS to tackle climate change.

Both private stakeholders and associations, citizens and politicians are now aware that it is necessary to change the traditional way of planning the transformation of the city and the territory by paying constant attention to the problems related to climate change.

The integration of the climate transition strategy within the Territorial Governance Plan on the one hand, together with the relevant regulations on a regional and national scale, will allow the creation of precise rules that will lead, through dedicated planning, to an increase of NBS in municipal area.

3.7.5 The public procurement processes

In Italy the open, restricted and negotiated procedures are the main type of NBS tendering processes. NBS in Mantova are especially implemented by local authority through public procurement processes. The internal departments interested in public procurement process are:

- Civil Works Department- Civic Works has the task of evaluating and verifying the possibility of NBS use instead of traditional solutions.
- Urban and environmental Departments - Urban and Environmental Departments have the task of introduce NBS in urban city planning. They can prescribe NBS as solution to mitigate and compensate negative impacts of other project.



- Private Buildings Authority department - Private Buildings Authority Department has the role of controlling private transformations that involve NBS. The future building regulations could foresee a specific section dedicated to NBS.
- This means that in this process the different departments of the Municipality have to work together. In Italy there are Green Public Procurement rules, in particular the national law on public procurement that obliges all Italian Public Bodies to adopt Green Public Procurement in their tendering process for green public areas. These Criteria are named Minimum Environmental Criteria. At the moment it seems to be a barrier in order of a market that is young and not still ready.

There are specific areas of application such as buildings, streets, public lights etc. In particular, in 2020 Italy approved new tendering process guidelines about:

1. planning of new green areas, renovation of others
2. management of public green areas
3. products furniture for green maintenance

The law gives some criteria in planning service of new green areas and in renovation areas. For new green areas there are some specific criteria for the selection of species that increase the resilience of green areas (for example water management).

3.7.6 Monitoring program and action plan

The monitoring tool that will be used for the RUP is integrated in the monitoring of the general planning of Mantova, carried out annually in order to verify the progress of the plan and the NBS scenarios generated. The monitoring system shall allow for collection, to prepare and publish information on the state of the environment in the area in which the effects of the interventions provided for in the Plan and those related to the pursuit of the objectives and implementation of the actions that the Plan has place, in order to identify and interpret any deviations from the forecasts. In this case, it will be necessary to formulate a proposal for re-orientation of the Plan through corrective actions in order to address the problems identified during the analysis.

The Monitoring Plan is articulated in different phases:

- Identification of indicators: these are the means by which the effects of the actions envisaged in the Plan, the pursuit of the objectives and the effective implementation of the actions are measured.
- Preparation of regular monitoring reports: they are drawn up by the City Council upon approval of the Plan and must inform about the progress of the indicators.
- Definition of the aims of the Administration: on the basis of the results of the Forum, the Municipal Administration can implement a reorientation of the Plan.

In this regard, it should be noted that the Municipality of Mantova has an active PGT monitoring reporting system, which is carried out through a set of indicators, also aimed at ensuring the consistency of the data with the issues included in the overall General Urban



Plan. It is important to note that the proposed set of indicators is part of and is integrated into a large database implemented by municipal offices for years, in the context of EMAS Registration of Mantova City Council.

3.7.7 Baseline data

The Municipality of Mantova has got an important baseline data, inside the Eco Management and Audit Scheme (Regulation EC n. 1221/2009 of the European Parliament and of the Council). The registration of the organization, since 2005, is for the monitoring of the principal environmental aspects and matrix.

The monitoring process and many indicators are linked to General Urban Plan and some of them are aligned with SECAP.

3.7.8 KPI

The proposal of the following KPIs is a sensor-based system. Thanks to new project financed by Fondazione Cariplo e Lombardy region planned by 2024:

- Installation of climate and weather columns for monitoring the NBS effects and therefore the impacts of mitigation actions;
- Installation of suitable sensors for detecting heat waves in urban areas;
- Installation of appropriate sensors to measure the impact of specific mitigation and adaptation measures.

Regarding KPIs the indicators decided to monitor are:

- CO₂ reduction near the selected areas respect baseline data.
- New tree planting (total trees)
- New canopy areas (m²)
- Surface temperature: Temperature variation near the area selected for the projects
- m² permeable surface in the area object of the project vs before
- Surface with vegetation (including green ground and trees);
- m³/y water in grid network

3.7.9 Review and adaptive management process

The RUP will be an integral part of the Territorial Governance Plan therefore, thanks to the monitoring that will be carried out annually, it will be possible to keep the management of the plan open and carry out any corrective actions.



| | Planning Process | | Evaluation process |
|---|--|--|--|
| Phase 1 Orientation and definition | <ul style="list-style-type: none"> - Initial plan orientation | | <ul style="list-style-type: none"> - Sustainability analysis of the initial guidelines |
| Phase 2 Elaboration and editing | <ul style="list-style-type: none"> - General objectives and reference scenarios - Specific objectives and lines of action - Alternatives definition - Actions and implementation tools | | <ul style="list-style-type: none"> - Definition scope of influence - Consistency assessment with superordinate plans - Estimation of environmental effects and evaluation of alternatives - Consistency between plan objectives and actions; definition of indicators - Environmental study |
| Phase 3 Consultation, adoption and approval | <ul style="list-style-type: none"> - Draft plan - Consultation documents for adoption and approval | | <ul style="list-style-type: none"> - Sustainability analysis of the observations |
| Phase 4 Implementation and monitoring | <ul style="list-style-type: none"> - Management and implementation - Corrective actions | | <ul style="list-style-type: none"> - Environmental monitoring and periodic evaluation |

Table 3.2: Review and adaptative management process

4 Medellín RUP

4.1 Abstract

4.2 Introduction

A RENATURING URBAN PLAN FOR MEDELLIN:

'Renaturing' is the process of transformation of urban space using Nature-based Solutions (NBS) that interact with green, blue and grey infrastructures and the ecological structure of cities. Through this re-naturalisation, we are promoting sustainable urban planning (particularly SDG 11: Sustainable cities and communities) and tackling challenges such as climate change, air quality, water management, green space management and public health.

The management of Medellín's green infrastructure and ecological structure has diverse needs and challenges, and takes place in a complex framework of laws and regulations. The Secretariat of Environment of the Mayor's Office of Medellín, is in charge of the development of the Re-naturalisation Plan (RUP) that is currently in the formulation phase, its objective is to generate synergies between plans and existing projects, validating these planning tools that complement the re-naturalisation exercises, these correspond to the Biodiversity Policy and its Ecosystem Services (PGBSE), Climate Change Action Plan (PAC), Comprehensive Environmental Health Policy (PISA), Municipal Environmental Plan (PAM), Municipal Disaster Risk Management Plan (PMGRD), Urban Drainage Plan (PDU), Sustainable Rural Development Plan (PDRS).

Through the construction process of this RUP, several opportunities have been created for Medellín to strengthen the work on the needs identified in the territory. In this sense, this process has opened the possibility for the city to contribute to the generation of guidelines for the implementation of Nature-based Solutions (NBS), lead the declaration of Nature-based Solutions with the Climate Leadership Group C40, constituted by a group of cities that join efforts to reduce carbon emissions in the atmosphere and adapt to climate change and, finally, contribute to position Medellín as an Ecocity.

It is estimated that the RUP's implementation will begin from the year 2022 with the projects that are framed in the Ecocity line, which are part of the current Medellín Futuro Development Plan 2020 – 2023, such as the Light Metro of the 80, North-South Cicloruta, Parks of the North River, among others.

URBAN GreenUP is a project funded by the European Union's Horizon 2020 program. Its objective is the development, implementation and replication of Renaturing Urban Plans in several cities of the European Union and beyond, with the aim of adapting to the effects of climate change, improving air quality and water management, as well as increasing the sustainability of cities through innovative NBS.

The program nominated three cities that are defined as "Front-runner cities": Valladolid (Spain), Liverpool (United Kingdom) and Izmir (Turkey), which will validate and demonstrate



the effectiveness of a range of urban NBS. As well as based on its own experience and previous initiatives, the project has four "follower cities": Mantova (Italy), Ludwigsburg (Germany), Binh Dinh-Quy Nhon (Vietnam) and Medellín (Colombia). These cities in the process of development, aim to establish their own Renaturing Urban Plans (RUPs), and will replicate the strategy and methodologies of re-naturalization established in the URBAN GreenUP and its green economy approach. The project began in 2017 and culminates in 2022, with the commencement of implementation of the RUPs of the participating cities.

This project seeks to respond to multiple environmental and socio-economic challenges in the participating cities, and use the response as an example for subsequent replications, where, in addition to the green transformation in the urban area, important results in social and economic terms are evidenced, creating a comprehensive strategy.

URBAN GreenUP plans to improve the quality of life in urban areas, generating awareness about the importance of preserving the environment among citizens, generating new market opportunities for companies at the international level, promoting the creation of transnational networks and synergies; highlighting the importance of the active participation of local communities in addressing climate problems through co-creation activities, and directly involving citizens who are at the centre of the green regeneration of their cities.

The contributions of the RUP for Medellín include:

- multiscale planning of NBS
- articulation between strategies and plans existing in the city
- establishing governance for a clear implementation pathway

This is further articulated in Figure 4.1.



Figure 4.1: Roles of this RUP

4.2.1 Green Management: Medellín's Progress

URBAN GreenUP defines ten challenges that cities face today and that they seek to address through the use of NBS. Medellín seeks to address nine of these challenges, as shown in Table 4.1.

| | | | | | |
|---|--|---|---------------------------------------|---|---|
| 1 | Climate Change Mitigation and Adaptation | | | | |
| 2 | Water management and quality | 5 | Urban Regeneration | 8 | Welfare and public health |
| 3 | Management of green and blue spaces | 6 | Participatory planning and governance | 9 | Economic potential opportunities and green jobs |
| 4 | Air quality | 7 | Justice and social cohesion | | |

Table 4.1: Challenges addressed by this RUP

In addition to the above, URBAN GreenUP identifies 4 base categories, of actions that seek to respond to the aforementioned challenges, these are called green infrastructure, greening, blue infrastructure and non-technical actions – social interventions. For the city of Medellín, given its context and the trajectory of interventions in the territory, these categories are redefined as follows: Green Infrastructure, within which greening is integrated as a direct action, Blue Infrastructure and Social Actions within the framework of a socio-cultural component that, in addition, is transversal to all categories.

Figure 4.2 shows the relationship identified in Medellín of the different challenges and categories mentioned above.

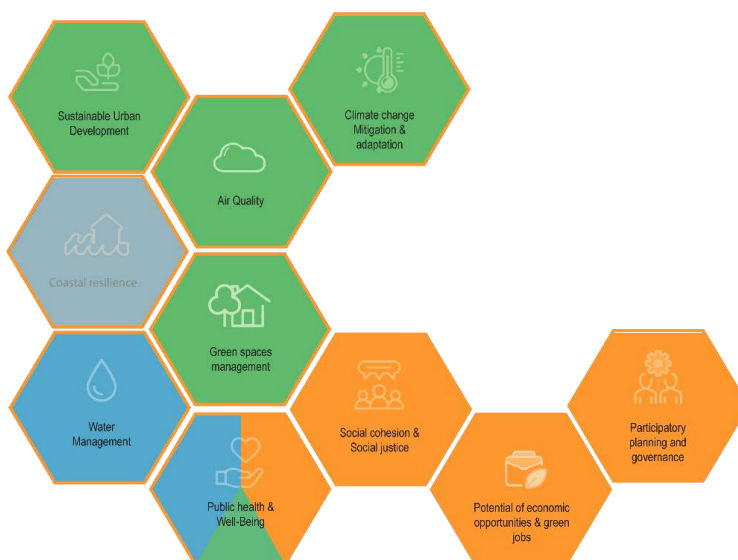


Figure 4.2: URBAN GreenUP challenges applicable to Medellín and its relationship with the categories of analysis (green, blue, grey infrastructure and social actions).

The URBAN GreenUP project proposes a catalogue of over 40 NBS, which Medellín groups and classifies in a list of 12 categories, directly related to the challenges, which will be detailed in Chapter 5. In Chapter 2, it will be discussed challenges further, noting their interactions and identifying that while all challenges must be addressed by the RUP, Climate Mitigation and Adaptation stands as the central and guiding challenge for this RUP.

4.2.1.1 A Multiscalar Planning Approach

The new Forestry Manual launched at the end of 2015, is a management tool of the green component in all areas (river – hillside – edge) of the municipality. It defines the urban forest as the set of all green spaces; recognizing those solitary specimens as isolated trees within the urban forest, and the areas with greater density as forest fragments, recognising whether these are natural or production areas with tree and/or herbaceous vegetation.

There is an integral approach to vegetation, with the aim of improving existing and future spaces, an improvement aimed at increasing environmental functions, goods and services in harmony with the rest of the components of the territory such as buildings, urban furnishings, mobility and public space, trying to achieve a balance between the natural and the artificial, improving the environmental quality of the city.

4.2.1.2 Management of Green Infrastructure Across Spatial Scales

The management of green infrastructure covers the whole process from the conception of the basic idea for the type of space to be intervened, to the maintenance that must be provided to it for its correct functioning and sustainability over time.

The management process is structured in four linear phases and a transversal one as follows:

- **PHASE I** - Planning, in which all green infrastructure is consolidated through the macro, meso and micro scales, much of it would be built in accordance with the strategic programs of the city.
- **PHASE II** – Design, from the macro, meso and micro scales, this will be developed in greater detail in the meso scale that is at the level of city project, in which a specific polygon is intervened with a specific program.
- **PHASE III** - Execution, phase in which the final project is physically embodied. It is the phase of construction of civil works elements and establishment of the plant component.
- **PHASE IV** - Maintenance, is which will guarantee the permanence over time of the different spaces that make up the green infrastructure.
- **PHASE V** – The social component, is transversal to each of the previous phases and is developed in each of these in a specific way.



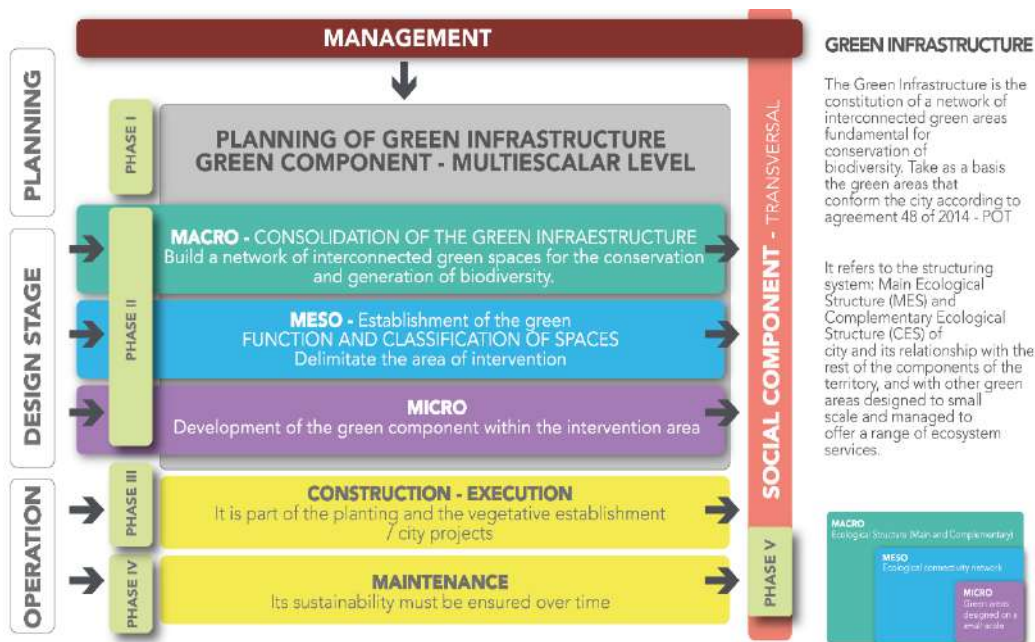


Figure 4.3: Management of urban greening considers the full project cycle at multiple scales

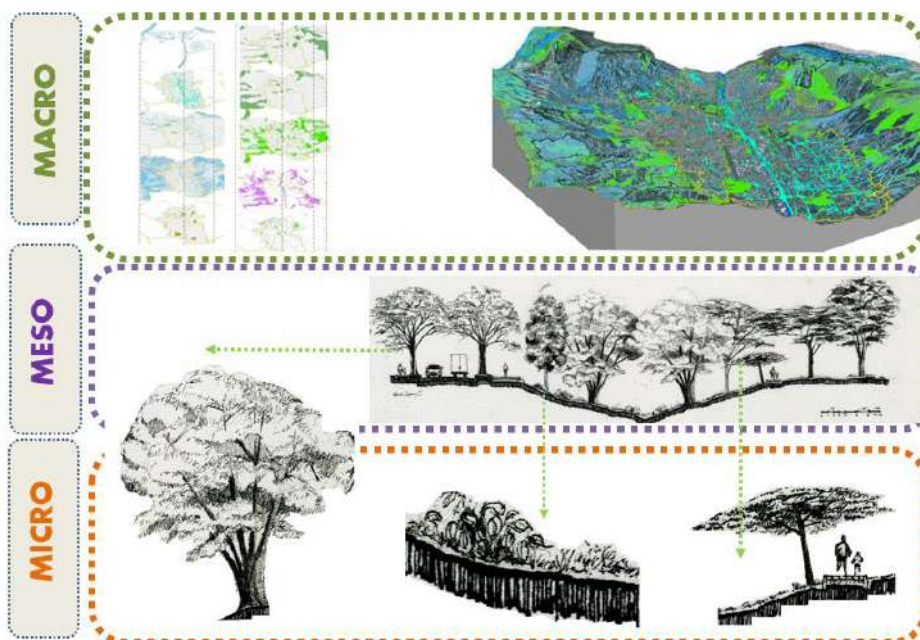


Figure 4.4: Multiscalar scheme for urban green analysis

The approach through different scales, facilitates the delimitation of the units of analysis, generating a higher level of confidence and coherence in the subsequent analyses, configuring a substantial context to each unit and the process itself, allowing the clear identification of the endogenous and exogenous processes that determine the dynamics of variability of the elements that make up the landscape.

The scales of approach proposed from the URBAN GreenUP project, approved with those proposed for the Medellín Re-naturalization Plan (RUP), oscillate between the regional and metropolitan system, which offer a context of elements and relationships given through the

connectivity of large green spaces whose opportunities are determined through the natural orographic and water structuring systems in particular, and the economic needs of large urban centres connected through the transport systems that energize these flows. This range of scales is shown in Figure 4.5.

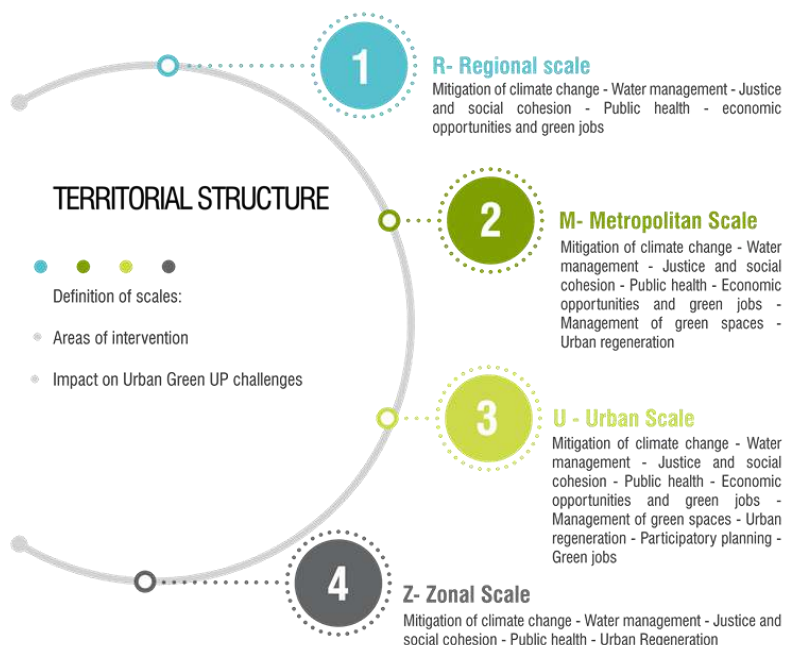


Figure 4.5: Definition of scales considered in the RUP.

The contextualization process is structured from a methodological strategy established by URBAN GreenUP and EKLIPSE, which defines territorial scales as a mechanism for approaching the context or projects that influence the challenges according to the landscape and environmental conditions of the territory.

In this way, regional, metropolitan, urban and zonal scales are established, which condition and determine the potential interventions according to the challenges and projects of the urban territory. Each of the territorial scales that give context to the territory and the challenges defined by the URBAN GreenUP are defined below:

- The regional scale is proposed from the regional natural systems, which structure the territory in environmental and natural terms, and give a general context and support to urban and local strategies. Likewise, the projects of regional scope that mainstream the territory are identified: Aburrá River Basin, Eastern Slope and Western Slope, which allow to counteract, adapt and optimize the territorial conditions in the face of the challenges of the URBAN GreenUP: mitigation of climate change, water management, justice and social cohesion, public health and well-being, and economic opportunities and green jobs.
- The metropolitan scale is proposed from the metropolitan natural systems, which define the environmental conditions of the metropolitan area of the Aburrá Valley, which consequently contextualize and determine the dynamics and environmental and natural strategies of the landscape units. In turn, the projects of metropolitan scope that structure

the territory are identified: Cerros Tutelares, Ancón Norte, Ancón Sur, Sistema Transversal Norte, Sistema Transversal Sur, and Sistema Transversal Centro, which allow to counteract, adapt and optimize the territorial conditions in the face of the challenges of the URBAN GreenUP: mitigation of climate change, water management, management of green spaces, urban regeneration, participatory planning and governance, justice and social cohesion, public health and well-being, and economic opportunities and green jobs.

- c) The urban scale is proposed from the urban natural systems, which support the strategic zoning in special units of analysis, defined as homogeneous zones from the biophysical component, which frame the urban fabric in the natural and environmental elements to generate potential and strategic areas of intervention. In this way, the urban projects that structure the territory are identified: Quebrada La Presidente, Quebrada Santa Elena and Quebrada La Guayabala, which allow to counteract, adapt and optimize the territorial conditions in the face of the challenges of the URBAN GreenUP: mitigation of climate change, water management, management of green spaces, air quality, urban regeneration, participatory planning and governance, justice and social cohesion, public health and well-being, and economic opportunities and green jobs.
- d) The zonal scale is proposed for vegetation of zonal impact, which define the intervention units as concrete and specific implementation strategies within each special unit of analysis, and allows contextualizing, materializing and prioritizing the methodology and the Urban Re-naturalization Plan. In this sense, the physical-spatial elements of local-zonal scope that materialize the territory are identified: Streets, Squares, Parks and Buildings, which allow to counteract, adapt and optimize the territorial conditions in the face of the challenges of the URBAN GreenUP: mitigation of climate change, water management, urban regeneration, participatory planning and governance, justice and social cohesion, and public health and well-being.

Defining these scales produced a framework of general guidelines for the integral development of the special units of analysis, applicable from the challenges of the URBAN GreenUP, which allow to establish the general actions that guide each unit of intervention.

4.2.2 Relationships of The City's Plans and The URBAN GreenUP Project

A number of existing strategic documents are important contextual factors for the operation of this RUP. These are summarised in Figure 4.6 and described below.



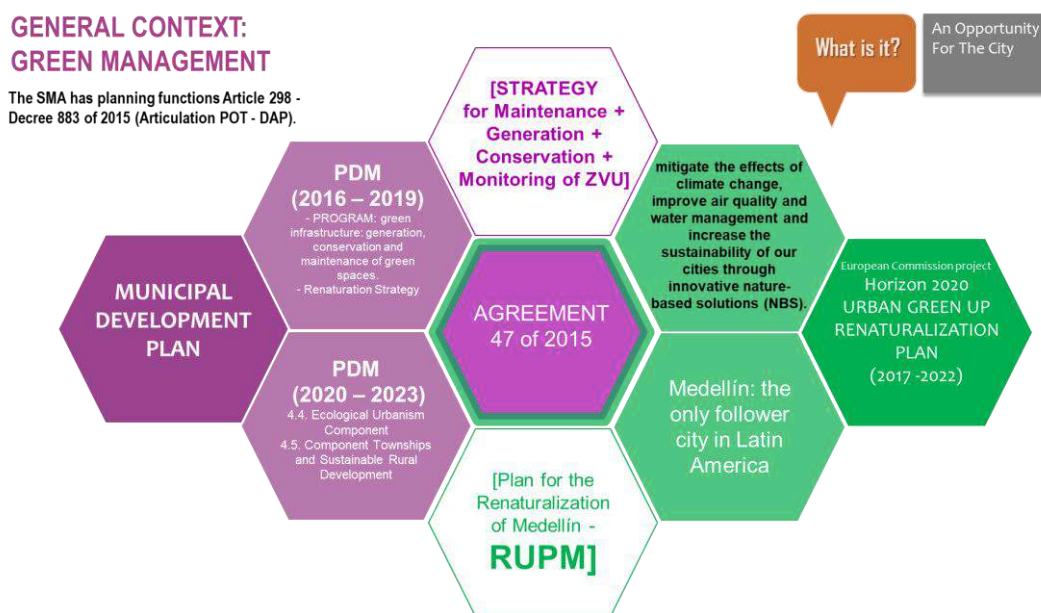


Figure 4.6: Relationship between Municipal Development Plan (2019-2019) and (2020 – 2023) and URBAN GreenUP Urban Project in the management of the green of Medellín

4.2.3 Municipal Development Plan 2016 - 2019 "Medellín Counts on You"

The Municipal Development Plan 2016-2019, combined the efforts that had been previously described and proposed guidelines for the city model in which the commitment to the integral development of the human being and a society that guarantees the necessary resources to have quality of life, living in harmony with others, was highlighted. Its general structure includes strategic dimensions, addressed through challenges, programs and projects.

One of these dimensions, called ‘A city commitment to the care of the environment’, sets out the guidelines to promote access to and improvement of the provision of quality public services, strengthen the prevention and management of threat and risk factors and increase efforts in the construction of an environmental awareness that leads to the responsible use and conservation of resources and, in general, to the sustainability of the city. This element of the Plan included a very large range of initiatives, encompassing green space creation, urban forestry, water management, waste management and climate change adaptation and disaster risk management. These have had significant effects on the city, as visible in Figure 4.7.



Figure 4.7: Pedestrian green corridor. Paseo Bolívar.

From a participatory planning perspective, the following projects stand out as triggers for important contributions:

- Planning and design of the green components of the city
- Masterplan for streams and green areas
- Environmental rehabilitation of landfill areas
- Climate change mitigation and adaptation plan
- Education and training in risk management
- Construction of disaster risk management policy

In terms of potential contributions to social cohesion, this strategic dimension presents the following projects:

- Management of protected areas and strategic areas for environmental sustainability
- River management
- Interventions and maintenance of creek channels
- Street lighting and lighting for the safety and enjoyment of public spaces
- Strengthening of social bodies
- Comprehensive management for the management of social emergencies and disasters
- Attention to social, natural and anthropic emergencies

From the Development Plan (2016-2019) through its program 7.1.1. *Green infrastructure: generation, conservation and maintenance of green spaces*, is specifically indicated in project 7.1.1.3. *Planning and design of the green component of the city: the assessment of the Ecological Structure, the declaration of the heritage tree and the strategy for the re-naturalization of the city.*

This strategy must respond to the maintenance, generation and conservation of urban green areas, as well as monitoring activities of the interventions carried out within the framework of the current administration and in turn, those previously developed; ensuring not only a monitoring of the state of the green infrastructure and its sustainability over time, but also facilitating the collection of functional data that allow to identify which of the interventions are most effective in responding to the mitigation and adaptation to climate change, the improvement of air quality, the generation of microclimates more friendly to the population, among other challenges.

For the city of Medellín, the confluence between what is indicated by the current Development Plan (2016-2019) and the participation in the URBAN GreenUP project was an opportunity for the territory, considering that, the objectives set in both documents seek the greening of the city, through a series of highly compatible guidelines that could be aligned, responding to both requirements and in turn, generating a planning instrument for the green of the city. It is important to note that, the Ministry of Environment of Medellín in accordance with the provisions of Article 298 of Decree 883 of 2015, performs both operational and planning functions on the green of the city.

While this plan has now been completed, it resulted in the production of a range of relevant policy that continues to operate. To aid implementation of the municipal development plan,



the city has powerful instruments which has been incorporating and articulating into its planning processes, especially the current Territorial Planning Strategy (Agreement 048 of 2014). A range of these plans under the Agreement 48 have direct relevance to the Medellín RUP, such as the Environmental Education and Culture Plan of Medellín 2012-2019 and the Municipal Disaster Risk Management Plan 2015 – 2030, as noted in Figure 4.8 below.

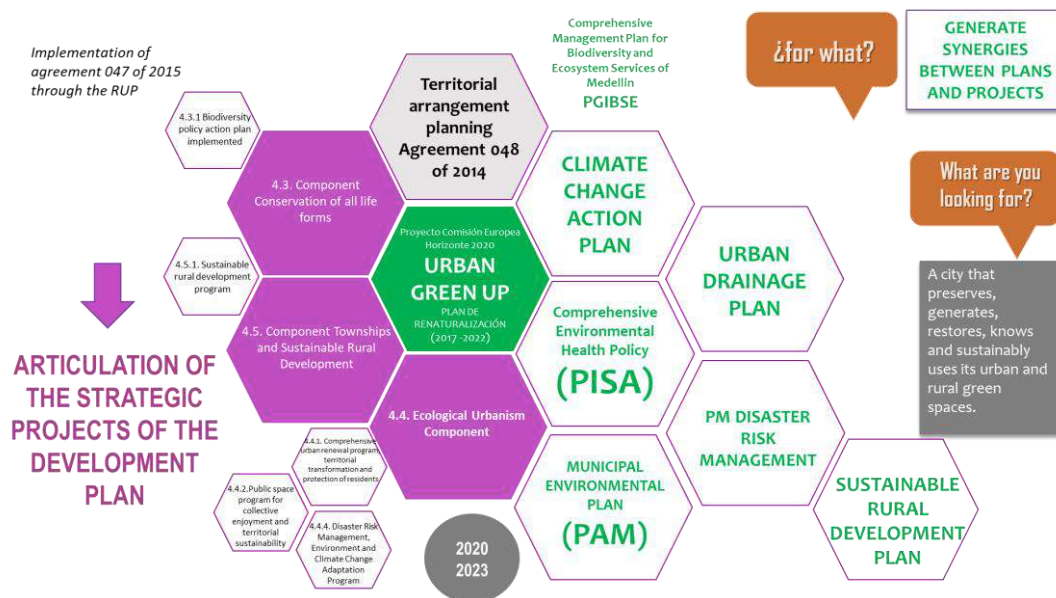


Figure 4.8: Plans under the municipal plan could interface with URBAN GreenUP

In 2017 Medellín reaffirmed the institutional commitment to promote the ordering, management and integral management of natural resources and the environment by defining the Environmental Policy of Medellín. Its development is based on international agreements, constitutional principles, and instruments defined in the law and in environmental, national and regional policy and in municipal and regional environmental public policies for the protection and defence of the environment. This policy frames the strengthening of citizen participation and management to generate an environmental culture aimed at the recovery, conservation, protection, management, and use of renewable natural resources, as mechanisms aimed at improving the quality of life and meeting the needs of the current and future inhabitants of the Municipality of Medellín.

Within this same framework, the Medellín Environmental Plan is established as the technical, methodological and operational instrument that defines and guides the development of the strategic framework for action of all potential municipal actors, aimed at stabilizing, balancing and qualifying the social and cultural processes and exchange of natural and environmental resources that are established between Medellín and the region for periods of twelve (12) years, from the year 2020 and is verified and adjusted in all its components, every four (4) years with the evaluation of compliance with the goals and indicators, according to the periods of the MIP.

These plans are instruments that transcend periods of government, so they are consolidating in the city long-term processes, which allow to generate changes in practices, both citizen and



institutional, as well as manifest themselves in direct transformations in the territories and new paradigms, which allow new cultural patterns that are evidenced in the improvement of the conditions of the inhabitants of the city.

The creative, convening, analytical, playful and formative capacity of art and culture, plays a preponderant role in the conception of the Urban and Environmental Plan of the Centre of Medellín. Their actions revitalize the public space and give it a meaning associated with the enjoyment of the collective space. The cultural institutions of tradition and many others that seek headquarters in mansions and premises of the centre, the student audiences and the communities that walk the streets of the commune are one of the most important capitals that deserve to be summoned to add ideas, once again, through their messages and actions. It is necessary to give a special place to the wealth of heritage and identities that the centre of Medellín gathers. The interaction between eras and uses, the generational dialogue, the reuse and re-significance of history as the structuring axis of the collective space, will be one of the priority aspects of the Plan for its capacity for communication, inspiration and commitment.

Similarly, the Plan outlines the concept of participation as a "process of dialogue for the empowerment of social actors, understood as the ability to influence decision-making."

This concept is complemented by the premise that participation is also a formative process of appropriation of knowledge. Participation is then an exercise that allows a concrete power relationship between social actors, which implies the recognition of the knowledge of others, as well as the responsibility of training in the topics to be participated. All this makes it possible to propose that we must train and recognize the notions of others regarding environmental policy, in order to achieve incident participatory processes.

These two conceptual approaches are key to understanding what has been proposed in environmental matters and their relationship with social practices in the city; as well as it is of utmost importance not to lose sight of them for the implementation of future projects. The Environmental Education and Culture Plan of Medellín presents 7 strategic lines:

1. Institutionalization of environmental education and the strengthening of CIDEAM
2. Inclusion of the environmental dimension in education form PRAE – PRAU
3. Inclusion of environmental education in education for work and human development in informal education
4. Training of trainers
5. Promotion of ethno-education in environmental education
6. Environmental education information, communication and dissemination system
7. Promotion of compulsory social service and military and police service

These strategic lines mark the path of insertion of environmental education, as a process in different areas, both schoolchildren and citizens for the transformation of environmental culture, integrating the subject into the training processes in the various phases of schooling, as well as recognizing that, from formal institutionalized education, such as that which does not belong to this field but that, if it impacts on citizen environments, such as the case of ethno-education.



4.2.4 Development plan 2020 – 2023 "Medellín futuro"

Since the development of the URBAN GreenUP urban project began, there was a consistent and aligned route from what the municipality of Medellín has aspired to in its planning and design. This was articulated correctly with the scope of the last development plan 2016 - 2019 for the management of green infrastructure and in the current development plan 2020 – 2023 in the strategic line of 'ecocity'. Figure 4.9 shows how a range of strategic projects fall under this plan.

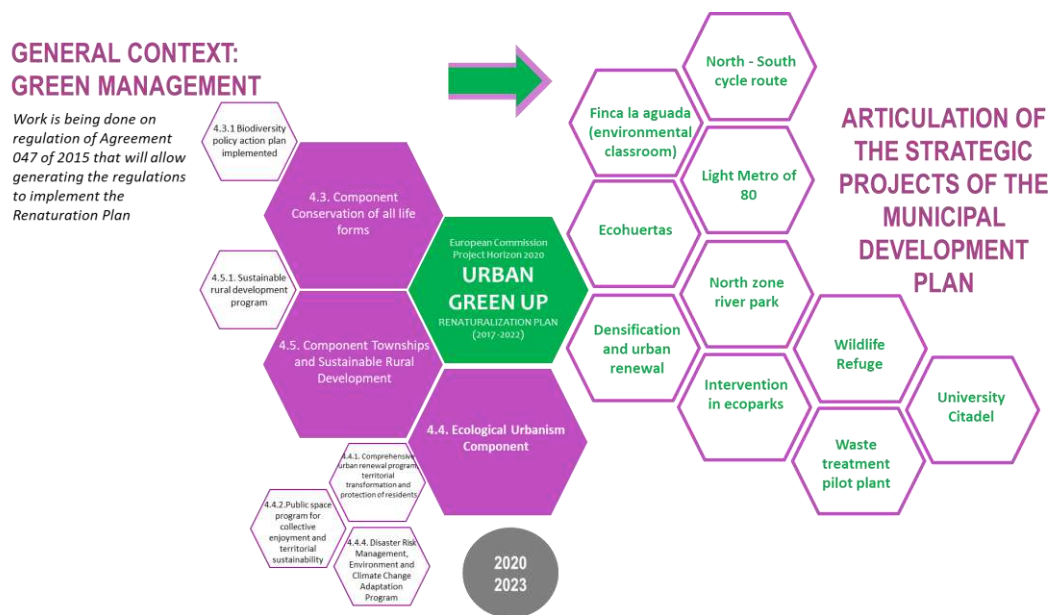


Figure 4.9: Strategic projects under the municipal development plan

With this horizon of collective meaning, in the Municipal Development Plan of Medellín Futuro 2020-2023, the Ecocity Strategic Line incorporates a commitment to the recognition of the interdependence between human beings and ecosystems in general, to promote alternative forms of production, reproduction of life and habitability in the territory.

To achieve this, it will be bet on sustainable mobility in public and private transport, clean and renewable energy sources, an intelligent and efficient waste management system and an urban proposal that substantially increases parks and green spaces. Consequently, we are preparing to initiate a profound change in the logic of an accelerated urbanization process that has ignored the limits of ecosystems; it has widened the gaps of inequality, inequality, poverty and acute environmental problems. Therefore, addressing the interdependence between nature, human interaction and economic relations requires a reading from sustainable and territorially equitable human development, which supports the socio-economic actions necessary to respond to the dynamics of growth of the city, while guaranteeing the recovery, reproduction and protection of nature respecting its limits and laws from a vision of strong sustainability.

We recognize that the transition to an Ecocity is not possible without the full recognition and empowerment of rurality, life and the peasant economy and, therefore, we tend towards "A



city that protects its rurality, is concerned with generating harmonious relations between the human being and its territory. That values and enhances its identity references, its main ecological structure and its natural resources. With global challenges on equitable economic and social development, co-responsible environmentally with the region" (Workshop with the members of the Governing Council and decentralized entities, 2020, January 20). With this orientation, it is vital to recognize the particularities of the territories, their potentialities and threats in order to assume risk management as a transversal axis. A comprehensive risk management that recognizes the importance of an exercise committed to adaptation to climate change and therefore the review of production processes so that progress is made in creating the conditions to make the transition to a sustainable city.

The purpose of the plan is to establish the bases of the ecological transition to direct Medellín to a future of sustainability, where the full enjoyment of the right to the city, the dignified habitability of its inhabitants and the functional and harmonious integration of rurality through the recognition and access to the rights of rural inhabitants is guaranteed.

This strategic line contains 5 components:

- Sustainable and intelligent mobility
- Public services, alternative energies and solid waste use
- Conservation and protection of all forms of life
- Ecological urbanism
- Sustainable rural development

In this respect the overarching 2020-2023 plan for Medellín is well primed to build on the work of its predecessor, as well as support the work of this RUP.

4.2.5 How we made this plan

Below is the methodological route for the Formulation of the RUP for Medellín applying the guidelines of the URBAN GreenUP to the city of Medellín as one of the follower cities, which seek to implement Nature-based Solutions actions from urban and rural environments to counteract the effects of climate change, improve air quality, ensure access to water and strengthen ecological connectivity. The development of this RUP advanced in three major phases:



Figure 4.10: Phases of the RUP development

For the elaboration of each phase a methodological route established by steps is designed, which will allow the development of the Renaturalization Plan for Medellín, according to the guidelines established by the URBAN GreenUP team – WP6.

Phase 1 "GENERAL STRUCTURE OF THE STRATEGY" – in which an extensive document review took place, encompassing both relevant project materials (e.g. URBAN GreenUP, EKLIPSE) as well as the highest-level strategic documents related to NBS in the city (these being the municipal plans and forestry manual, discussed above).

Phase 2 "RENATURALIZATION STRATEGY" included a few key steps, in which the bulk of the RUP was conceptualized and evidenced.

- Recognition and analysis of the detailed legal and policy context
- Identification of institutional competences, functions and capacities
- Identification of financing instruments
- Construction of a proposal for a geospatial information structure and territorial status indicators (supply and demand) and follow-up to the NBS to be implemented
- General guidelines for the generation, maintenance and qualification of the green infrastructure and ecological structure of Medellín.

Phase 3 corresponding to the development and implementation of the "RENATURALIZATION PLAN" for Medellín, this phase began from 2020 as a strategic component, and will be developed between 2020 and 2022. The proposals of the programs and projects for the Implementation of the NBS (Nature-based Solutions) will be generated, and the formulation, management and implementation of the Greening plan.

Throughout this process, we have sought to engage with stakeholders within the municipality and community. The overall process is summarised below.

SCHEDULE AND ACTIVITIES

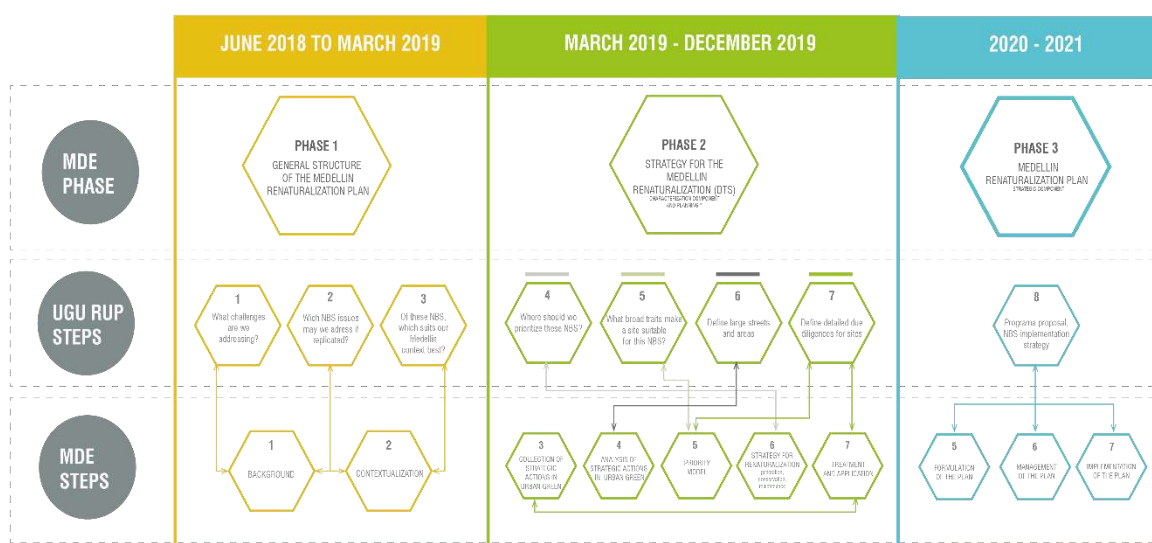


Figure 4.11: Medellín RUP schedule and activities



4.3 Analysis of key challenges

Within the framework of the URBAN GreenUP project, various instruments of qualitative and quantitative techniques applicable to the leading and follower cities have been built over the time of this initiative that allow to identify the priority challenges for each city, the greatest barriers to overcome and the Nature-based Solutions (NBS) to be implemented, in order to generate the greatest possible environmental and socioeconomic benefits according to the characteristics of each territorial system.

Within the Ministry of Environment of the city of Medellín, a multidisciplinary team has been formed in charge of contextualizing to the local reality the instruments and methods proposed by the URBAN GreenUP project, this implies not only the study and application of these instruments, but their interpretation and the generation of alternative or complementary proposals that allow the effective implementation of a RUP for the city of Medellín.

The co-benefits analysis emerges as a first response to the prioritization requirements of the city's challenges within the framework of the URBAN GreenUP Up project and is gradually integrated into the dynamic process of construction of the strategy for the re-naturalization of Medellín, subsequently transforming itself through the territorial context, its dynamics and own needs.

The recognition of the multiplicity of relationships between the different challenges or challenges in the same space-time, seeks the prioritization of three (3) of the nine (9) challenges applicable to the city of Medellín; however, it identifies the need to think about the total set of challenges on the territory, and considers that the actions generated on each challenge individually have an impact on the other challenges at different levels and scales.

Therefore, before selecting the priority challenges, an evaluation of the co-benefits of addressing each challenge was conducted.

4.3.1 Evaluation of co-benefits of the challenges of URBAN GreenUP

Although the proposed exercise is focused on the selection of three challenges, throughout its conceptual base it poses as a great challenge for cities in the world, to face the mitigation and adaptation to climate change, responding to it through the installation of Nature-based Solutions (NBS), which must be spatially determined by the RUP, which is expected to be built from 2020. To this same commitment is added, in parallel, the municipal Climate Change Plan, currently under development, projected from the Development Plan (2016-2019). The above is consistent with the results obtained in the co-benefit analysis. In addition, it was evidenced that:

- The direct influence of each challenge on the others can be understood as the impact of that possible action on a given challenge and how that action influences the other challenges. That is why, the assessment made from each of the dimensions of the landscape (natural, built and social), concluded in this first approach that any direct action on the management of green space, that is, on green infrastructure, green



spaces of the city and the ecological structure will have direct effects not only on air quality, but they will be framed within the specific actions for the adaptation and mitigation to climate change of the city. In addition, they will be able to generate opportunities for the strengthening of economic potential and green jobs, and to promote actions against water management.

- The levels of relationship of each of the 9 challenges that apply to the city of Medellín based on the co-benefits or relationships that exist between them. For example, in this case, Challenge 4: Air Quality is shown as tertiary, which does not mean that it is a challenge of minor importance but that, the improvement of its indicators is based on the attention of more operational challenges, such as Water Management (Challenge 2) and management of Green Spaces (Challenge 3), so if we work on these challenges progressively our indicators improve because the level of co-benefit between them.
- The challenge that greater dependent relationships or the one on which greater effects could occur due to direct actions of the other challenges corresponds to Challenge 8: Public Health and Welfare.
- The challenge with the highest level of causal relationship compared to the other challenges is the one that corresponds to Challenge 3: Management of Green Space, as can be seen in Table 4.2 and Figure 4.12.

| CHALLENGES | 1 | 2 | 3 | C 4 | 5 | 6 | 7 | 8 | 9 | Influence/Cause |
|-------------------|-------|------|------|------|------|------|-------|------|-------|-----------------|
| | | | | | | | | | | TOTAL |
| Challenge 1 | 0 | 2 | 2 | 3 | 2,25 | 2 | 2,25 | 2,75 | 1,75 | 18 |
| Challenge 2 | 2,25 | 0 | 2 | 2,25 | 2 | 2,5 | 2,75 | 3 | 2 | 18,75 |
| Challenge 3 | 2,75 | 2,25 | 0 | 2,75 | 2,75 | 2,25 | 2 | 3 | 2,75 | 20,5 |
| Challenge 4 | 3 | 1,25 | 2 | 0 | 1,75 | 2 | 2 | 2,75 | 1,25 | 16 |
| Challenge 5 | 2,5 | 2,25 | 3 | 2,5 | 0 | 2,25 | 2,25 | 2,5 | 2,75 | 20 |
| Challenge 6 | 1,75 | 2,75 | 2,5 | 2,25 | 2,75 | 0 | 2,5 | 2,25 | 3 | 19,75 |
| Challenge 7 | 1,25 | 2,5 | 2,5 | 2,25 | 2,75 | 3 | 0 | 2,5 | 2,75 | 19,5 |
| Challenge 8 | 2,25 | 2,75 | 2,5 | 2,75 | 2 | 2 | 3 | 0,75 | 1,5 | 19,5 |
| Challenge 9 | 2 | 1,25 | 3 | 1,75 | 2,75 | 2,5 | 2,5 | 2 | 0 | 17,75 |
| Dependency/Effect | 17,75 | 17 | 19,5 | 19,5 | 19 | 18,5 | 19,25 | 21,5 | 17,75 | |

Challenge 1: Adaptation and Mitigation to Climate Change. Challenge 2: Water Management. Challenge 3: Management of Green Space. Challenge 4: Air Quality. Challenge 5: Urban Regeneration. Challenge 6: Participatory Planning and Governance. Challenge 7: Justice and Social Cohesion. Challenge 8: Public Health and Welfare. Challenge 9: Economic Potential and Green Jobs.

Table 4.2: Evaluation of co-benefits of the challenges of URBAN GreenUP



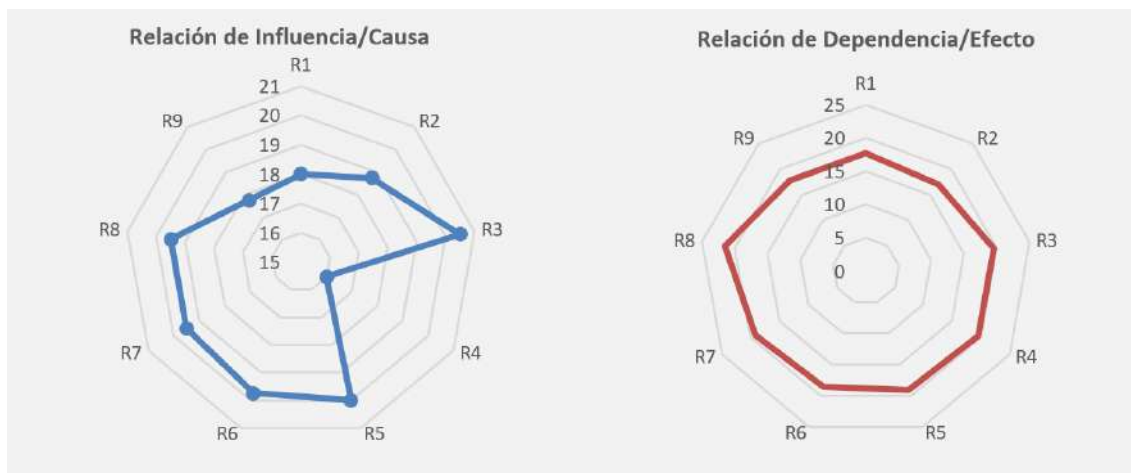


Figure 4.12: Relationships between challenges in URBAN GreenUP

It is important to highlight that being a circular matrix that was worked to prioritize these challenges, all must be worked on simultaneously, managing the levels of focus that are required according to the social, environmental and political context. In this way, the challenge of climate change is understood as the encompassing theme that seeks to mitigate, solve and adapt through the challenges analogous to the effects caused by this anthropogenic phenomenon, as can be seen in Figure 4.13.

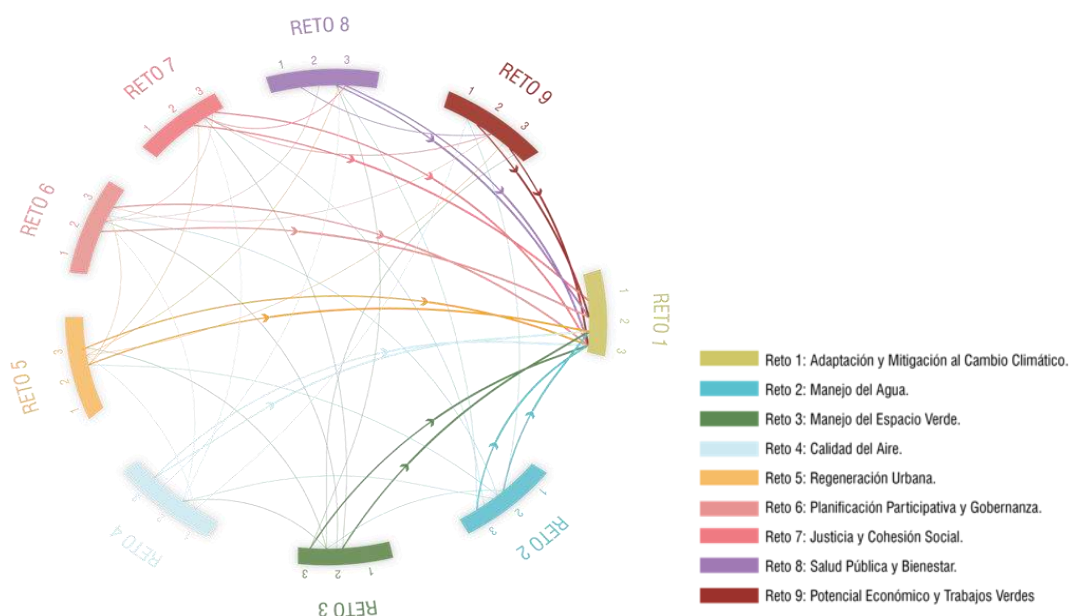


Figure 4.13: Co-benefits among the challenges, with Reto 1 (Challenge 1 - Climate Change) clearly playing an 'umbrella' role

In the environmental context, benefits outside the central objective of an initiative are commonly called co-benefits. In the area of mitigation initiatives, for example, ecosystem goods and services are considered co-benefits. These services provide components of well-being at different levels and sectors. The relationships between them are complex, with

dilemmas and sometimes the need to prioritize between carbon capture, biodiversity, water, green spaces and circular economies.

One of the projects contained within the **Horizon 2020** program is Nature 4 Cities, with documents that exemplify the actions to be implemented for each of the challenges faced by current societies, based on the benefits resulting from these actions that will benefit the mitigation of the problem that describes the challenge or in turn generate adaptation scenarios to a problem already installed after its reduction of risk level. Below are each of the 9 challenges applicable to Medellín correlated with the priority actions identified.

- **CHALLENGE 1 - Mitigation and Adaptation to Climate Change**

According to the definition of the challenge given by Eclipse, this concept includes the ability to react and respond to stress and external stimuli such as climate change, and the potential to improve the state of some problem through active or passive behaviour, in this case reducing greenhouse gases or through carbon sequestration strategies.

There are a number of factors that threaten the quality of life in most cities in the world, the increase in pollution levels, urban heat islands, floods, decreased biodiversity and high-risk events resulting from climate change make all eyes on this phenomenon that directly affects human health and well-being. However, it is this who must generate mitigation actions to their levels of carbon emissions, which is why the development of cities must be from a climate resilience based on two concepts for this challenge, which are explained below.

Mitigation: "Defined as an anthropogenic intervention to reduce sources or improve sinks of greenhouse gases" (International Panel on Climate Change (IPCC), 2001). It seeks to definitively eliminate the long-term risk to the quality of human life and its properties.

Adaptation: "It is defined as the adjustment in natural or human systems to a new or changing environment, in response to actual (or expected) climate stimuli and their effects, that moderate harm or take advantage of beneficial opportunities. Several types of adaptation can be distinguished, including anticipatory and reactive adaptation, private and public adaptation, and autonomous and planned adaptation." (International Panel on Climate Change (IPCC), 2001).

These two aspects are closely related, as any adaptation in an ecosystem can further influence its mitigation potential. It is then that actions to be implemented that directly benefit the mitigation or adaptation to climate change are presented:

1. Increase the area of (or prevent the loss of) green spaces, in particular wetlands and tree cover, for both direct and indirect storage of CO₂.
2. Improve mitigation by choosing species that adapt to future conditions, maximizing net carbon sequestration through such selection.
3. Increase green roofs and walls to cool the city through efficient energy consumption.



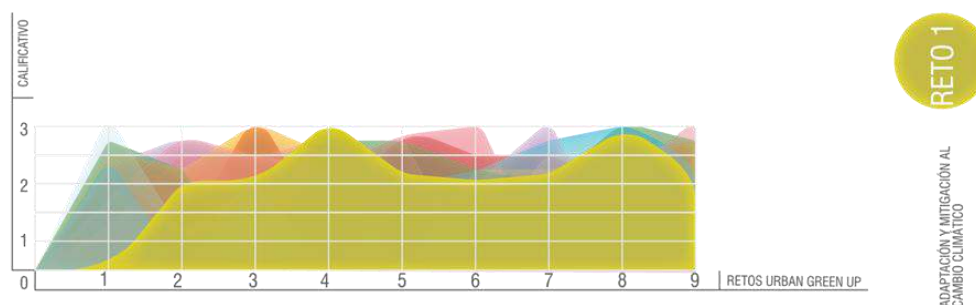


Figure 4.14: Co-benefits curve for challenge 1

Understanding the scale of intervention and impact of the Nature-based Solutions implemented is one of the main challenges for their planning and execution. Actions to mitigate climate change can range from the micro scale (building/street), the meso-scale (city/country) and the macro scale covering the entire planet, due to the decrease in the concentration of gases it proposes; on the other hand, adaptation to climate change is intervened only at the micro and meso-scales, having its impacts on them.

- **CHALLENGE 2 - Water management**

Growing urban populations, pollution, and economic activities in urban areas place water resources under severe stress, increasing pressure on the quality and quantity of water resources. Sociologists and geographers have identified in the management of water resources in cities the way in which power relations can shape water landscapes. Such social power relations are perceived in material elements as in the discursive elements of the water landscape: for example, in the uses of water that are reflected in the landscape and in the modalities of access and exclusion to water (for example, in the differential provision of rich and poor neighbourhoods), in the modes of administration (for example, privatization) and in the debates around water governance.

NBS aimed at improving this challenge should have within their impact indicators a component of inclusion and reduction of the gap of geographically unequal and socially unjust water landscapes that reflect that accumulation. According to the definitions given by the URBAN GreenUP, water management is based on how Nature-based Solutions can contribute to solving the following problems: flood risk, water shortages and water quality.¹⁹

Generally, water management focuses on solutions based on strengthening the natural water cycle; enriching the natural processes of storage, infiltration and evapotranspiration of water in cities. However, factors such as the quality of water supply and flood mitigation (or prevention) should be the ideal combination leading to sustainable urban water management in cities.

¹⁹ Erik and others, *Stolen Waters: Water Dispossession and Social Mobilization. Water Justice*, ed. by Aline; Arroyo and Boelens Rutgerd (Lima: IEP, Quito: Justicica Hídrica; IEP Institute of Peruvian Studies, 2013).

Nature-based Solutions used in urban water management help to move closer to a natural water cycle. They are usually based on increased storage, infiltration and/or evapotranspiration processes. Therefore, they can mitigate flooding by the rainwater storage source, lead to more sustainable urban water management by favouring groundwater recharge and increasing the area of urban vegetation and can also contribute to mitigating UHI (Urban Heat Island) and increased evapotranspiration.

Nature-based Solutions can lead to sustainable water management by increasing infiltration zones. To prevent the city from continuing to flood, rainwater must be discharged into areas planned for this purpose, where phytoremediation processes are subsequently carried out and temporary storage is carried out; away from places where damage to infrastructure may occur. These are some of the actions that lead to strengthening water management in cities:

1. Increase in vegetation area.
2. Increase in water storage, due to an increase in permeable soils.
3. Reduction of water pollution, from inclusion and education to citizenship.

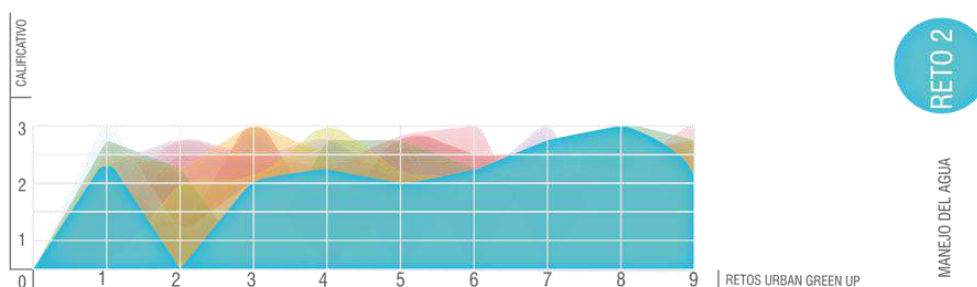


Figure 4.15: Co-benefits curve for challenge 2

• CHALLENGE 3 - Green Space Management

Green spaces are important reserves of urban biodiversity, providing resources, ecosystem services and habitats for species of interest, improving structural and functional connectivity at an urban level. Urban green spaces provide a variety of benefits, or ecosystem services, that contribute to the physical, psychological and social health of cities and citizens. However, in many cases, these benefits are not distributed equitably among the various urban populations, as the connections between ecosystem services associated with cultural events and environmental determinants associated with health, do not become sponsors in urban design and city planners.

Urban regeneration points to improvements in the economic, physical, social and environmental conditions of an area that has been subject to negative changes and is considered vulnerable. When the equipment or NBS installed in the public and private spaces (to a lesser extent) are spaces of conservation and environmental importance, they have a

related social function. This aspect is determined by the uses and customs of the various groups that demand to cover different needs in green spaces.²⁰

Green and blue spaces are useful instruments for urban planners to achieve the development of a sustainable urban structure. These spaces have important physical and functional characteristics, but also a value from the social and cultural dimension; they can house heritage and aesthetic elements and be used for recreation, leisure and citizen encounter. Potential actions to implement:

1. Maintain or restore connections between semi-natural areas on a city scale.
2. Give priority to NBS design that favours spontaneous biodiversity and native species.

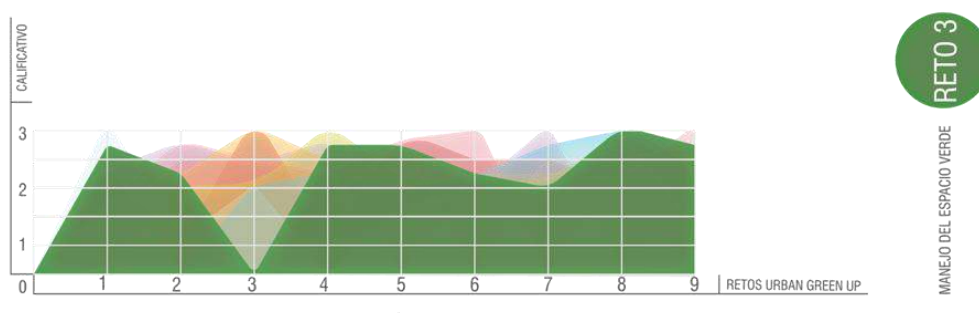


Figure 4.16: Co-benefits curve for challenge 3

- **CHALLENGE 4 - Air quality**

NBS based on the creation, enrichment or restoration of ecosystems in anthropized environments play an important role for the removal of pollution and carbon dioxide, reducing air temperature (which decreases the generation of secondary pollutants) and increasing the concentration of oxygen, contributing to an atmospheric composition beneficial to human life.

The cumulative effects of air pollution can cause social and economic deprivation that exacerbate poverty and inequality, for Medellín there is also a direct relationship between health. Specifically, air quality impacts can affect the increase of inequality in economic growth, which has also been demonstrated by several studies. For example, cognitive effects on children represent lower school performance and future development, affecting future economic development, productivity, eventually impacting economic growth. Diseases related to poor air quality represent an increase in household spending on the treatment of these diseases, which will be more expensive and complicated to treat when moving to adulthood, more in sectors bordering on extreme poverty.²¹

Air quality is also a major concern around the world, particularly in urban areas, due to its direct consequences on human health, plants, animals, infrastructure, and historic buildings

²⁰ Manuel de Jesús Flores-Xolocotzi, Ramiro; and González-Guillén, 'Planning of Systems of Green Areas and Public Parks', *Mexican Journal of Forestry Sciences*, 1.1 (2010), 18–24.

²¹ UNICEF *On the Effects of Air Pollution on Health*, 2016
<https://www.unicef.org/publications/files/UNICEF_Clear_the_Air_for_Children_30_Oct_2016.pdf>.

(among others). Improving air quality depends on a host of factors, such as the amount and type of traffic, location, or weather. The role of the NBS in this regard is limited and can be considered as a small aid to other measures with a much greater impact, such as the reduction of the levels of car parks in cities, or in turn less impactful and more collective means of transport. Actions that bet on air quality:

1. Planting trees around the city: in private domestic gardens; along the streets; in urban parks.
2. Installation of green biofilters in static urban sources of pollutants in: extraction chimneys of city tunnels, and in extraction chimneys of underground parking lots.

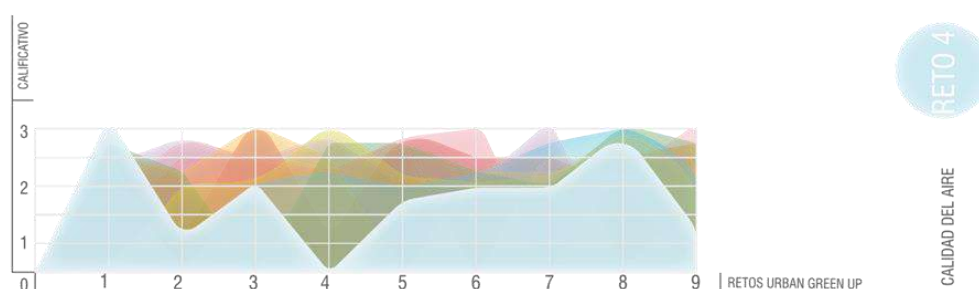


Figure 4.17: Co-benefits curve for challenge 4

• CHALLENGE 5 - Urban Regeneration

This concept helps to improve the economic, physical, social and environmental conditions of an urban area that has been subjected to a negative change and is considered as non-resilient. Nature-based Solutions must harmonize, be aesthetic and attractive, have an urban development and structure, design, social justice, urban ecology and relationships with the uses of water and energy.

Making use of innovative urban planning mechanisms, interdisciplinary planning methods for the design and implementation of NBS, including the development of innovative social models for long-term positive management.

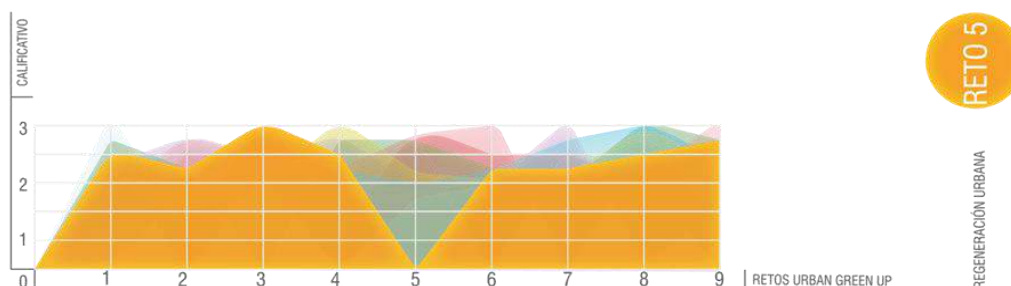


Figure 4.18: Co-benefits curve for challenge 5

• CHALLENGE 6 - Participatory planning and governance

The design and implementation of Nature-based Solutions requires a holistic approach and transdisciplinary planning that reconciles different types of knowledge. Likewise, NBS should

focus on the interests and perceptions of citizens, examining policy changes when ecosystem services are incorporated into the planning framework.

This challenge refers to the absences that have occurred in general to consult the needs of the communities and the way in which the solutions that aim to solve such problems also reflect, enhance or strengthen the processes they solve. Many of the additions of strategic urban ecological nodes, such as parks, or protection of the buffer zones of the streams have ignored the importance of including communities in decisions and solutions, which directly involves the well-being, sustainability and appropriation of equipment.

Nature-based Solutions require planning approaches and governance architectures that support accessibility to green spaces, maintaining their quality for the provision of ecosystem services. This challenge raises the need to make evident different factors that contribute to the integration of ecosystem thinking into urban planning, considering the understanding of citizens' interests and perceptions and examining changes in policy narratives when incorporating the ecosystem. In addition, planning strategies should focus on citizens' interests and perceptions, examining changes in policy narratives by incorporating the ecosystem services framework into planning.

This challenge is to implement solutions to generate a sustainable and livable urban environment, so its objective is to evaluate the effectiveness of using Nature-based Solutions when addressing the consequences of intentional and unintentional urban transitions. Consequence of the environmental, social, economic and political variables that the challenge must take into account when implementing any type of action on the territory, since it will be measured in the ability to plan and generate direct benefits on the social, environmental and urban dimensions of cities. Actions to implement:

1. Increase ecological connectivity across NBS sites and residential areas.
2. Create a regular pattern of recreation green spaces in the city.
3. Reevaluate the planning processes of the city in order to make them sustainable over time.
4. Conserve and maintain green spaces on the outskirts of the city.

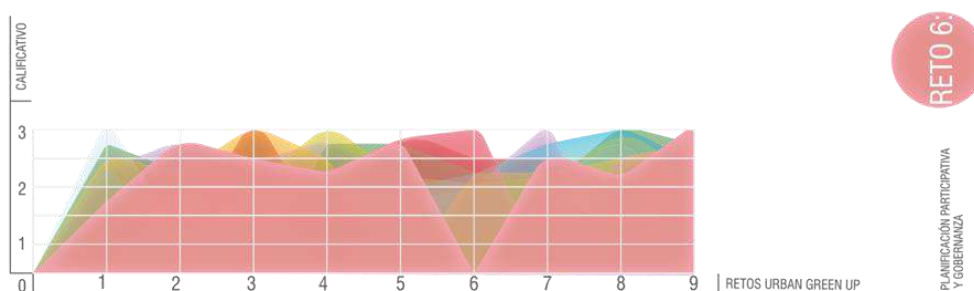


Figure 4.19: Co-benefits curve for challenge 6

• CHALLENGE 7 - Justice and Social Cohesion

This concept aims to understand environmental justice and social cohesion supported by Nature-based Solutions in urban areas, through a multidimensional study and approach.



It recognizes the need to manage effective mechanisms in space that reflect a society composed of a diverse set of social groups, with different requirements, rights and duties that need mutual support, cooperation and acceptance. Likewise, it admits the need to plan green infrastructure, paying attention to environmental justice issues, which includes the elements of distribution, procedure and recognition of environmental benefits, as well as their effects. Or the understanding of aiming to reduce the *unequal distribution*, both social and spatial, of environmental qualities. This challenge is based on the recognition of typically excluded individuals and groups (e.g. migrants, women, people with disabilities).²²

In the case of Medellín, it is directly related to the periphery areas where there is typically less access to quality green public spaces. These populations are characterized by being mostly vulnerable. Strategies that recognize in planning the lack of representativeness and accessibility along with the inequity in the enjoyment of values added to ecosystem services understand a concept of justice and recognize the intrinsic privilege that exists within cities and green public spaces^{23,24}.

The concepts of environmental justice allow the procedural and distribution impacts of NBS in urban environments, in addition to allowing to address both the quality of the process and its results (who benefits from the NBS). A precondition is the recognition of diverse needs and interests, but also attention to capacities and spaces to participate, given that NBS are planned and implemented in a specific local context, it is also important to consider to what extent these build on or improve the quality of existing local social networks. Addressing the social context through the concept of social cohesion allows expanding the set of social elements, that is, social capital as the main indicator of the value of social networks in cities. Actions to implement:

1. Clear participatory processes for your participants that show you what benefits you will obtain in the agreed times.
2. Mapping social inequalities before implementing NBS, to counteract possible social inequalities at the end of the process.
3. An increase in the construction of share capital, in relation to the realization or implementation of NBS.
4. Improve and maintain structural social dimensions, such as: ties with family and friends, being part of organized associations, integration with the community. As well as more cognitive aspects such as trust, feeling attached to the neighbourhood, help, tolerance and respect.

²² Manuel de Jesús Flores-Xolocotzi, Ramiro; and González-Guillén, 'Planning of Systems of Green Areas and Public Parks', *Mexican Journal of Forestry Sciences*, 1.1 (2010), 18–24.

²³ Pérez Jaramillo, J; Patiño, J.M; García, JC; Tarchópulos, D; Cardona, 'El Plan de Ordenación Territorial 2014: Un Modelo Territorial Para La Intervención Estratégica' (Medellín: Alcaldía de Medellín. Administrative Department of Planning -DAP-, 2014), pp. 2–17 <https://upcommons.upc.edu/bitstream/handle/2117/80323/97BCN_PerezJorge.pdf>.

²⁴ Joan Martínez Alier, 'Ecological Conflicts and Environmental Justice', *Papeles*, 103 (2008), 11–27 <<http://europa.sim.ucm.es/compludoc/AA?articuloid=682992>>.



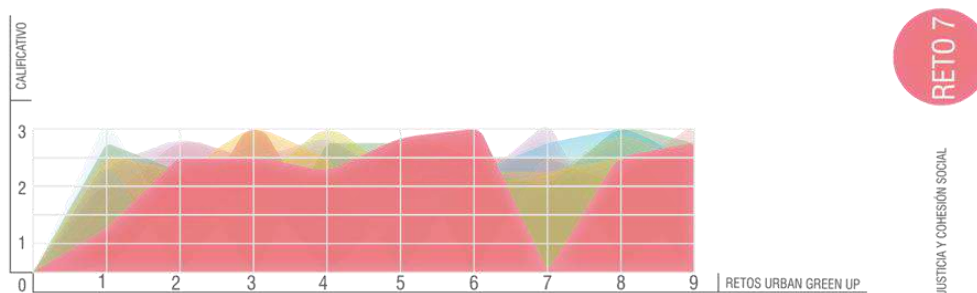


Figure 4.20: Co-benefits curve for challenge 7

- **CHALLENGE 8 - Public Health and Well-being**

Nature-based Solutions can contribute to a wide range of physiological and psychological benefits, improving overall human health. The urban environment significantly affects the health and well-being of residents. NBS are intended to improve the health and well-being of urban residents through the provision of ecosystem services in urban green spaces. Many of the ecosystem services of climate regulation address threats to environmental health, however today, noise is a major social problem with a proven sky-high impact on health (hearing impairment, development of cardiovascular problems, stress, insomnia, etc.), especially in urban and peri-urban areas where noise sources are numerous and varied, and are closely related to air quality due to the CO₂ emitting agents present in the urban centres of today's cities.

The urban environment significantly affects the health and well-being of residents. NBS are supposed to improve the health and well-being of urban residents through the provision of ecosystem services by urban green spaces.

From the approach of Environmental Justice in political ecology, it is understood that access to ecosystem services in city planning has a relationship with the class, gender and political power of citizens. In Latin America (Brazil and Colombia) the worst rates of respiratory diseases, water quality, deficit access to green public areas, and diseases are associated with the most vulnerable populations. A NBS that aims to solve this challenge must contemplate within its planning an impact indicator that develops this relationship between society and vulnerability and public health. However, the other six challenges identified for the city of Medellín^{25,26}, due to their origin and impact, they carry within themselves, an incidence from the social that can be contextual. Actions to implement:

1. Decreased noise level through NBS implementation.
2. Improved quality of life and facilitated access to NBS.

²⁵ V. Raymond, C.M; Berry, P; Breil, M; Nita, M.R.; Kabisch, N.; of Bel, M; Enzi, *An Impact Evaluation Framework to Support Planning and Evaluation of Nature Based Solution* (Wallingford, United Kingdom, 2017); Alvaro Javier Idrovo, 'Surveillance of Pesticide Poisonings in Colombia', *Public health*, 1.2 (2000), 36–46.

²⁶ Magdalena Vilma, Rodríguez Morales; Bustamante, Leticia M; Alfonso, Mirabal, 'The Protection of the Environment and Health, A Current Social and Ethical Challenge', *Cuban Journal of Public Health*, 4.37

3. Improve public health through direct enjoyment of NBS.

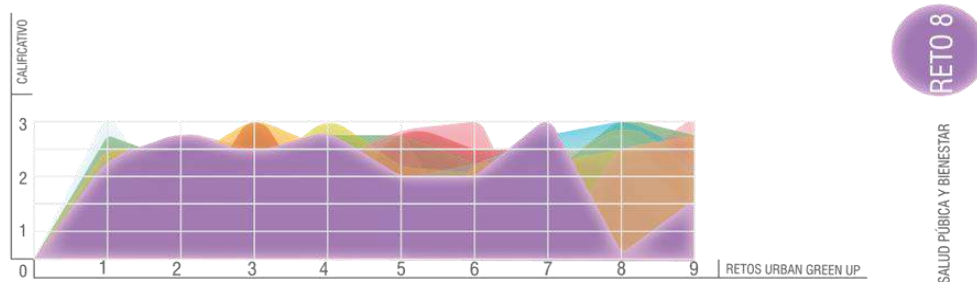


Figure 4.21: Co-benefits curve for challenge 8

• CHALLENGE 9 - Potential for economic opportunities and green jobs

Increasing green areas and implementing nature-based interventions results in considerable economic benefits (e.g. increasing real estate values, positive effects on health, improvement in water management). Likewise, NBS generate co-benefits that can create opportunities for "green businesses".

It is identified that the qualification of urban green space has considerable joint benefits. Through, for example, the increase in real estate values, positive health effects, better water management or recreational services²⁷. Actions to implement:

1. Specification of more durable and durable elements and components in the design phase of NBS projects.
2. Design to ensure the recyclability of segregated materials.
3. Establish public-private partnership agreements as part of the strategic implementation of productive NBS in urban areas.
4. Promote policies that encourage the use of biological waste and biomass from local urban areas (public or private) for energy production.

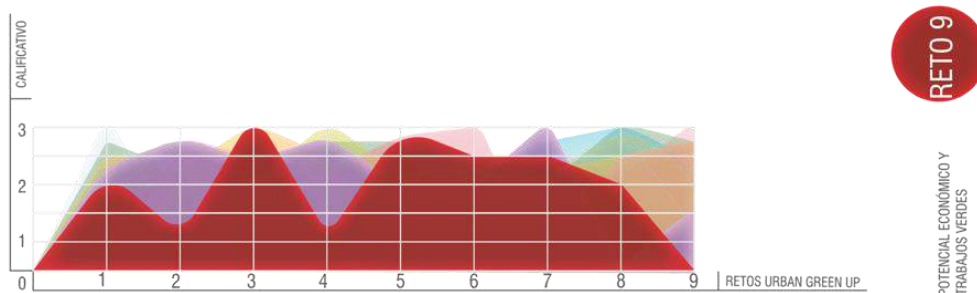


Figure 4.22: Co-benefits curve for challenge 9

²⁷ Kabisch, Nadja; Horst, Korn; Stadler, Jutta; Aletta *Nature-Based Solutions to Climate Change Adaptation in Urban Areas* (Cham, Switzerland: Springer International Publishing AG, 2017) <<https://doi.org/10.1007/978-3-319-56091-5>>.

4.3.2 Criteria for the prioritization of challenges in the city of Medellín

After the analysis of co-benefits and the review of their results, the prioritization exercise of the nine challenges applicable in the local context proposes a classification according to their operability and possibility of management in the context of the RUP for the city of Medellín. The central objective is **Challenge 1: Adaptation and mitigation to climate change**, accompanied by five (5) challenges that have specific physical-spatial implications in the territory and that can be transformed in a concrete way through the implementation of NBS, these are: **Challenge 2: Water management and management; Challenge 3: Management of green and blue spaces; Challenge 4: Air Quality** and **Challenge 5: Sustainable Urban Development**.

Challenges 7 and 8 describe the ultimate purpose of implementing a re-naturalization plan, **Challenge 7: Justice and Social Cohesion** and **Challenge 8: Welfare and Public Health**, while Challenges 6 and 9 describe the strategies needed to ensure long-term sustainability of the plan, **Challenge 6: Participatory Planning and Governance** and **Challenge 9: Opportunities for Economic Potential and Green Jobs**, as can be seen in Figure 4.23.

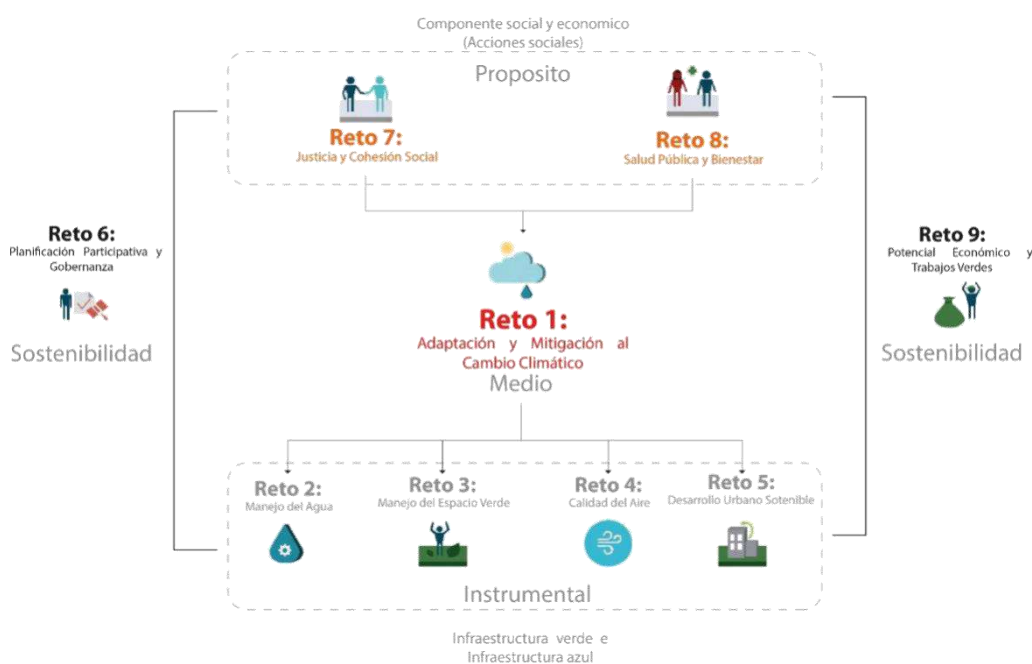


Figure 4.23: Classification of challenges in the prioritisation process

As the first conclusion of the exercise of prioritization of the challenges in the context of the formulation of a RUP for the city of Medellín it is assumed that its greatest purpose will be to achieve well-being, public health, justice and social cohesion, through the activation of a strategy for mitigation and adaptation to climate change, with operational instruments that improve water management, the management of green and blue public space, air quality and sustainable urban development, promoting participatory planning and governance that generates in the long term economic opportunities with green jobs.

As a second step, it is proposed to give territorial visibility to the challenges of URBAN GreenUP, not only in order to diagnose or generate a baseline for the RUP Medellín, but to build an instrument of easy reading and understanding that makes possible to make quick, effective and relevant decisions when intervening in the city through Nature-based Solutions – NBS.

4.3.3 Identification of the Territorial Offer in the City of Medellín

In this section, it is quantified the land cover in Medellín, recognizing that the mix of land uses is a vital foundation to preparation of the RUP.

Green and blue infrastructures are strategic tools for climate adaptation and mitigation. These are measures of very different typology and operation, but they share attributes such as multifunctionality, the generation of various ecosystem services, and their high capacity to adapt to territorial and socio-environmental dynamics.

The concept of green and blue infrastructure has been consolidating, over the last few years, as opposed to **grey infrastructure**, associated with the physical-spatial structures of transport, public, social or commercial services. All infrastructures have been comparable with engineering systems that provide the basic functions of society, their name of greys is related to their lack of connection with the green and blue ecosystems that precede them in the territory in which they settle.

According to the European Commission, **green infrastructure** comprises a "network of high-quality natural and semi-natural areas with other environmental elements, designed and managed to provide a wide range of ecosystem services and protect the biodiversity of both rural and urban settlements." It also points out that, "being a spatial structure that generates benefits from nature to people, green infrastructure aims to improve nature's ability to provide multiple and valuable ecosystem goods and services."

On the other hand, **the blue infrastructures** directly related to the green ones, includes the components or processes related to water, their identification part of admitting the supply, efficiency and management of water as one of the aspects of greater relevance when establishing a fight against the effects of climate change and social and environmental inequality. Proper planning and management of water and its associated ecosystems is essential for the integrated improvement of territorial processes, not only because of the issues related to the resource, but also because of its psychological and emotional effects on citizens.

Table 4.3 shows a first exercise of identification of the infrastructures for the urban and rural territory of the city of Medellín, each of these elements is part of the territorial offer susceptible to be intervened through Nature-based Solutions (NBS), they are the basis and support to initiate effective actions that generate long-term processes in the path of adaptation and mitigation to change climatic.



| Infraestructura | Estructura | Categoría | Elementos | Unidades | Dimensión |
|-----------------|---------------------------|---------------------------|------------------------------|-------------------------------|----------------|
| VERDE | Estructura Ecológica | Áreas protegidas | Acuerdo 48 | Áreas m ² | 105,985,608.39 |
| | | | RUNAP | Áreas m ² | 167,118,324.59 |
| | | Red ecológica | Sistema Orografico | Áreas m ² | 58,413,051.38 |
| | | | Red Ecológica | Áreas m ² | 98,165,727.30 |
| | | | Red Ecológica Complementaria | Áreas m ² | 30,431,141.11 |
| | Estructura Funcional | Espacio Público | Arbolado urbano | Unidad | 40,927.00 |
| | | | Zonas Verdes de Quebradas | Áreas m ² | 873,404.88 |
| | | | Zonas Verdes de EPE | Áreas m ² | 4,832,048.12 |
| | | Zonas Verdes de Movilidad | Áreas m ² | 2,419,340.90 | |
| | | Equipamientos | Zonas verdes equipamientos | Áreas m ² | 880,282.02 |
| AZUL | Estructura Ecológica | Red ecológica | Sistema Hídrico | Áreas m ² | 215,837,980.78 |
| | | | Acuíferos | Áreas m ² | 25,060,431.31 |
| | | | Zonas de recarga | Áreas m ² | 288,429,958.20 |
| GRIS | Estructura Funcional | Movilidad y Transporte | Paraderos | Unidad | 10,361.00 |
| | | | Red Peatonal | Longitudinal m | 760,694.77 |
| | | | Sis. Transporte Masivo | Longitudinal m | 83,835.14 |
| | | Espacio Público | Espacio Público Efectivo | Área m ² | 1,821,945.43 |
| | | | Espacio Público Proyectado | Área m ² | 43,712,834.18 |
| | | Equipamientos | Construcciones Equipamientos | Área ocupación m ² | 3,269,704.50 |
| | Estructura socioeconómica | Usos | Contrucciones en usos mixtos | Área ocupación m ² | 11,183,147.26 |
| | | | Predios en usos mixtos | Área m ² | 32,887,344.55 |

Table 4.3: Identification and classification of the territorial offer for Medellín. Source: own elaboration 2019

As can be seen in the following series of maps, Medellín has a powerful and broad green and blue infrastructure, the identified green infrastructure is present in **35%** of the municipal territory, while the blue infrastructure is evident in **36%**. That is, a good percentage of the municipal area has the capacity to offer ecosystem goods and services. Having this natural offer is a very positive starting point if it is expected to establish complex networks and systems that generate dynamic processes of urban re-naturalization.

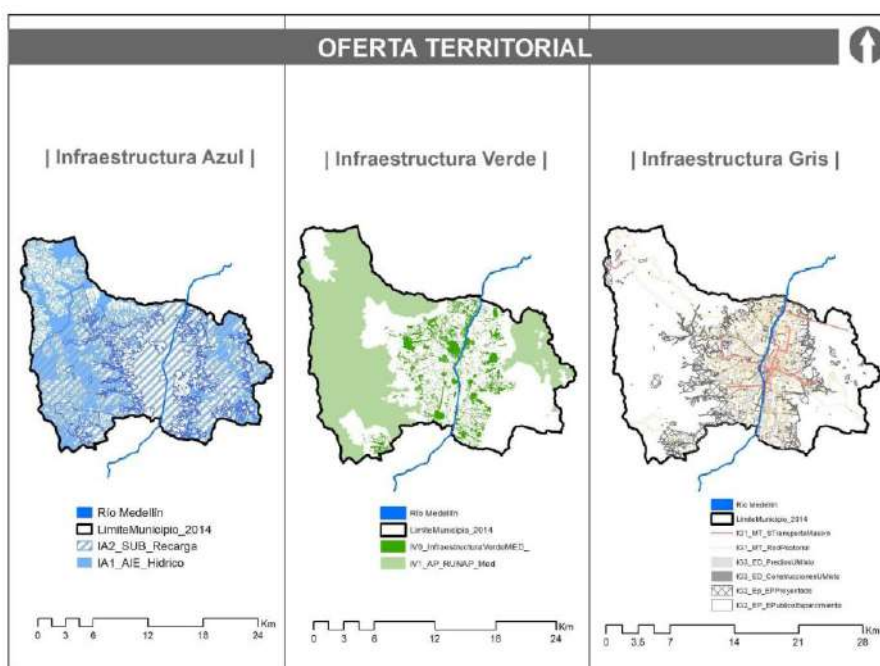


Figure 4.24: Mapping of infrastructure types

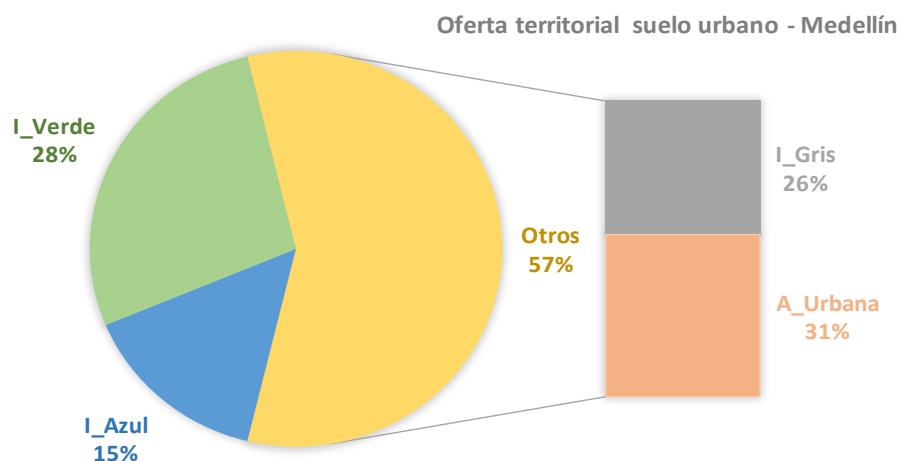


Figure 4.25: Graph of the distribution of territorial supply in urban land – Medellín

When concentrated on urban land, it is observed that in **its 42%** the presence of green infrastructure with **28%** and blue infrastructure with **15%** is evident, while in **26%** there is a presence of grey infrastructure with the potential to be intervened through solutions based on nature and articulated to the ecological dynamics of natural infrastructures, as can be seen in Figure 4.25.

The **green infrastructure** on urban land occupies **3,177.67 ha**, equivalent to **13.09 m²/inhabitant**, of which **11.8%** is part of the ecological network, with a territorial offer of **5.64 m²/inhabitant**. The green areas total about **1,775.92 ha**, **15.7%**, of which the green areas associated with the equipment are the ones with the highest proportion and they offer **4.10 m²/inhabitant**, as can be seen in Table 4.4.

| Infraestructura | Elementos | Unidades | Área Urbana | % urbano | m ² /hab |
|-----------------|------------------------------|----------------------|---------------|----------|---------------------|
| VERDE | Áreas protegidas Acuerdo 48 | Áreas m ² | 1,596,861.62 | 1.4% | 0.67 |
| | RUNAP | Áreas m ² | 1,607,022.12 | 1.4% | 0.67 |
| | Sistema Orografico | Áreas m ² | 3,055,461.99 | 2.7% | 1.28 |
| | Red Ecológica | Áreas m ² | 13,424,853.16 | 11.8% | 5.64 |
| | Red Ecológica Complementaria | Áreas m ² | 7,211,617.21 | 6.4% | 3.03 |
| | Arbolado urbano | Unidad | 40,927.00 | 0.0% | 0.02 |
| | Zonas Verdes de Quebradas | Áreas m ² | 868,715.08 | 0.8% | 0.36 |
| | Zonas Verdes de EPE | Áreas m ² | 4,716,455.70 | 4.2% | 1.98 |
| | Zonas Verdes de Movilidad | Áreas m ² | 2,404,164.97 | 2.1% | 1.01 |
| | Zonas verdes equipamientos | Áreas m ² | 9,769,866.29 | 8.6% | 4.10 |

Table 4.4: Green infrastructure on urban land

In the urban land of the city of Medellín the area occupied by the surface drainage network, structural component of the **blue infrastructure**, is approaching **1,692.48 ha**, equivalent to **14.9%** of the urban territory, with an offer of **7.10 m²/inhabitant**. This network on which we constantly exert pressure cannot be separated from the territorial supply of groundwater, which can be intervened and protected in strategic and priority ways to address the effects of climate change (Table 4.5).



| | | | | | |
|------|------------------|----------------------|---------------|-------|-------|
| AZUL | Sistema Hídrico | Áreas m ² | 16,924,817.20 | 14.9% | 7.10 |
| | Acuíferos | Áreas m ² | 25,060,431.31 | 22.1% | 10.52 |
| | Zonas de recarga | Áreas m ² | 94,338,598.19 | 83.2% | 39.60 |

Table 4.5: Blue infrastructure on urban land

Within the components identified as part of the **grey infrastructure**, the effective and projected public space become structural, a high potential of spaces for the consolidation of an effective system in urban land is evident, **1,366.07 ha** would significantly increase this territorial offer, managing to increase it by **5.73 m² / inhabitant**. The integration of legal entities into a strategy for the implementation of Nature-based Solutions (NBS) can be structural for the city of Medellín, since there is an important territorial offer of properties dedicated to mixed uses, **3,288.73 ha** have a high potential to be intervened and articulated to the NBS network. (Table 4.6).

| | | | | | |
|------|-------------------------------|-------------------------------|---------------|-------|-------|
| GRIS | Paraderos | Unidad | 10,210.00 | 0.0% | 0.00 |
| | Red Peatonal | Longitudinal m | 639,076.62 | 0.6% | 0.27 |
| | Sis. Transporte Masivo | Longitudinal m | 77,442.00 | 0.1% | 0.03 |
| | Espacio Público Efectivo | Área m ² | 1,657,425.07 | 1.5% | 0.70 |
| | Espacio Público Proyectado | Área m ² | 13,660,720.62 | 12.1% | 5.73 |
| | Construcciones Equipamientos | Área ocupación m ² | 3,077,452.42 | 2.7% | 1.29 |
| | Construcciones en usos mixtos | Área ocupación m ² | 11,183,147.26 | 9.9% | 4.69 |
| | Predios en usos mixtos | Área m ² | 32,887,344.55 | 29.0% | 13.80 |

Table 4.6: Grey infrastructure on urban land



4.4 Regulatory context

The planning, generation, management and management of the green infrastructure and ecological structure of Medellín has needs and challenges of various kinds. The technical, social and institutional challenges find a means of expression and materialization in the different administrative instruments that regulate public and private action in green public space.

At the highest level, a set of national policies that establish the general conceptual framework in which local policy and regulation efforts operate. To the extent of institutional competences and territorial context, the Medellín Re-naturalization Plan must reflect and develop the intent of these higher policy documents.

As part of this part of the RUP, the full range of the relevant rules is identified, contemplating for each of them, the relationship of their objectives and objects of regulation, the actors involved, the mechanisms and instruments that it establishes or mentions, as well as some observations and comments that were considered relevant for the management of the green public space and the process of formulating the RUP for Medellín. This extensive analysis forms Annex 1.

From this analysis, a synthesis is presented, with some general recommendations to guide the construction of the RUP for Medellín.

4.4.1 National Policy Framework

In addition to the Political Constitution of Colombia, which includes numerous articles related to the need to guarantee rights and duties in relation to a healthy environment, sustainable habitat, and social welfare, and the conservation of natural resources and the natural and cultural heritage of the nation, Colombia has a wide range of sectoral policies that are relevant to frame and guide from the conceptual point of view, through approaches, principles, and strategic and instrumental elements, a Re-naturalization Plan for Medellín. Among them the most relevant are:

- National Environmental Education Policy
- National Climate Change Policy
- National Policy on Biodiversity and Ecosystem Services
- National Risk Management Policy
- National Urban Environmental Management Policy
- National Public Space Policy
- National Policy on Sustainable Buildings
- National Water Resource Policy
- National Food and Nutrition Security Policy



It is important to carry out, within the framework of the formulation of the Renaturalization Plan, a detailed reading of these, with a view to their effective consideration, given that all the environmental action developed by the territorial entities must contribute explicitly to the concretion of these national guidelines.

Additionally, and in connection with these policies, it would be necessary to identify and analyse the set of national laws and decrees directly and indirectly related to the Renaturalization of Medellín, and that offer instrumental and operational elements to specify sectoral policies at all territorial scales and areas of competence, guaranteeing the principles of regional harmony, regulatory gradation and rigor.

4.4.2 Identification of Standards Related to the Re-naturalization of Medellín

Below is an abbreviated compendium of the rules that the city has in direct and indirect relation to green infrastructure and ecological structure, organized according to the entity that developed, adopted and published them.

The sources of information consulted for this compendium were two: i) ASTREA System, the Virtual Legal Library of the Municipality of Medellín; ii) Technical documents related to green infrastructure and ecological structure in Medellín. As a form of control over the completeness of the list and the validity of the identified standards, the compendium obtained was submitted to review by technical and legal professionals of the Ministry of environment of Medellín.

A list of the identified standards and their main elements is presented in Annex 1 and a graphical synthesis in Figure 4.26 below.

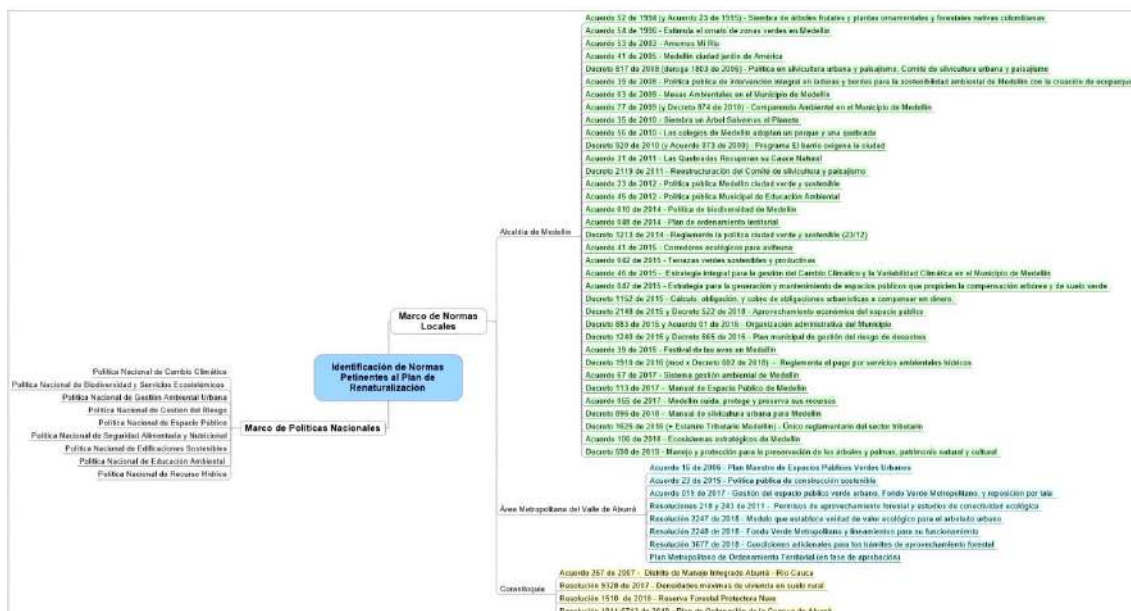


Figure 4.26: List of National Policies and Local Norms Identified as Relevant to the Strategy and the Renaturalization Plan for Medellín



The standards identified correspond to three levels of government. These are local government (Mayor's office), Metropolitan Government (Aburrá Valley Metropolitan Area) and regional government. Annex 1 includes an extensive and detailed list, offering an outline of each relevant initiative and policy.

As is visible in Figure 4.26, local initiatives are especially numerous, including fundamental policy documents (e.g. for Environmental education, biodiversity, urban forestry and territorial planning) as well as discrete programs such as corridors for avifauna, incentives for tree planting, and a program of streambank restoration in ravines. Metropolitan initiatives in the Aburrá Valley Metropolitan Area offer higher-level policy guidance on networks of green space, forestry, and financing. Regional instruments for Corantioquia define management principles for large spatial units such as National Parks and river basins.

PRINCIPLES ARISING FROM THE REGULATORY REVIEW

As a plan that seeks to improve implementation and coordination of NBS delivery in Medellín, our review of the range of relevant documents sought to produce insights in how the RUP can support a systematic delivery of NBS within this framework.

The set of current regulations related to re-naturalization for Medellín shows a broad legal framework around the management of urban and rural green that would enhance the generation, maintenance and improvement of the green infrastructure and ecological structure of Medellín. However, elements are required to operationalize and specify the strategies proposed in the regulations.

Key points arising from this analysis include:

- An adequate articulation and intra- and inter-institutional coordination, which allows to minimize the fragmentation of functions or to increase the unity of criteria around the planning and management of the green, especially in the Secretariats with greater roles in the matter: Environment, Physical Infrastructure, and Administrative Department of Planning.
- Consistency is important. Communication channels that form repositories of institutional information (via intranet), virtual courses for contractors and municipal officials, and institutional messages or permanent campaigns, promote the concrete, operational and instrumental elements that contribute to the management of NBS.
- Articulation and traceability with the regulations established in the POT around the management of green, which tends to the fulfilment of commitments and tasks in each of the Secretariats, and that are articulated around the common objective of planning and efficiently managing the green spaces of the city.
- Identification of problems and taking advantage of the strengths arising from the range of existing planning instruments, many of which are yet to be implemented for a range of reasons. In many of them there are opportunities for articulation and synergy that it is necessary to value, for a more comprehensive planning and management of the urban landscape that incorporates all the dimensions of the urban and rural habitat and the



expectations and needs of the communities. A fundamental role in this context seems to fulfil, in addition to the POT, the Climate Action Plan for Medellín in the process of formulation, and the Medellín Environmental Plan that should be updated next year.

- Financing is important. It must be defined the operational channels to increase financing for the green infrastructure and ecological structure of Medellín. This would enable permanent financial, technical and operational resources to carry out the monitoring, follow-up and verification of the actions proposed by the regulations. In this sense, everything related to urban planning obligations and economic use of public space is strategic.
- It is fundamental for a strategy and plan of renaturalization to think about the procedures and mechanisms of governance, as well as the elements of social control and institutional authority. It is essential to recover the confidence of citizens in government action for the management of green, and for this they must be reviewed, in conjunction with the Ministry of Government, the National Police, the Ministry of Education, the Secretariat of Citizen Culture, the Agency for the Management of Landscape, Heritage and Public-Private Partnerships, the Administrative Department of Planning, the Secretariat of Infrastructure, the public service companies, and the urban environmental authority, the planning processes for the generation of urban green, as well as those for reporting environmental infractions, economic use of public space, among others on which the maintenance and conservation of existing ones depends.
- Finally, it is necessary to strengthen and articulate the information and monitoring systems of the interventions carried out, and particularly, to evaluate the effectiveness of the projects, programs, and instances adopted through the different administrative acts, which allows to explicitly identify the successes, limitations, and obstacles presented, susceptible to be improved through various strategies and administrative, technical, and legal processes.

All of the above can be detailed and concretized not only from Agreements or Decrees but also from Resolutions, Circulars, Concepts, Protocols, and Technical Sheets, which define or specify guidelines to enable and materialize the actions and procedures required to manage greenspaces and encourage the implementation of Nature-based Solutions (NBS), fed the technical, financial, and governance dimensions necessary in the construction of the Plan of Renaturalization of Medellín.



4.5 Guidelines for governance, institutional articulation and landscape management for the renaturalization of Medellín

Following the analysis of legal and policy instruments outlined in the previous chapter, as an activity of internal socialization of results and participatory construction of the RUP, a workshop was developed with officials of the entities most directly committed to the management of the green infrastructure and the ecological structure of Medellín, investigating key governance functions and competences, synergies between actors, existing relationships, and proposals for technical and institutional improvement for management.

This workshop established a set of guidelines for NBS governance, linked to specific stakeholders, to progress the delivery of NBS in Medellín.

Based on the reading of the regulatory framework (Chapter 3), the stakeholders specified in Table 4.7 were identified, and invited to engage in the development of governance guidelines.

| Stakeholders | Number of Mentions | Stakeholders | Number of Mentions |
|---|--------------------|--------------------------------------|--------------------|
| Ministry of the Environment | 30 | Family Compensation Funds | 2 |
| Metropolitan Area of the Aburrá Valley | 25 | Environmental tables and collectives | 2 |
| Planning Administrative Department | 23 | Government of Antioquia | 2 |
| Secretariat of Infrastructure | 18 | Antioquian Society of Ornithology | 2 |
| Corantioquia | 13 | Educational Institutions | 2 |
| Secretary of Education | 9 | Parque Explora Corporation | 2 |
| Academy | 9 | Police Inspections | 2 |
| Ministry of Finance | 8 | ANDI | 2 |
| EPM | 7 | DAGR | 2 |
| Secretariat of Citizen Culture | 7 | Sec. Communications | 2 |
| Ministry of Health | 7 | Secretariat of Supplies | 2 |
| ISVIMED | 5 | Secretariat of Social Inclusion | 2 |
| Miscellaneous Companies | 5 | Market | 1 |
| City Council | 5 | Unites | 1 |
| Sec. Territorial Management and Control | 5 | Banks | 1 |
| Government Secretariat | 4 | Metroparks | 1 |
| Municipal Police and Army | 4 | Santa Fe Zoo | 1 |
| Botanical Garden of Medellín | 4 | Territorial Planning Council | 1 |



| | | | |
|--|---|--|---|
| EDU | 3 | Media | 1 |
| Camacol | 3 | Ministry of Environment and DS | 1 |
| Economic development | 3 | Arví Park Corporation | 1 |
| Civil society | 3 | DIAN | 1 |
| NGOs | 3 | Control entities | 1 |
| Metropolitan Planning Council | 3 | Humboldt Institute | 1 |
| Secretariat of Security | 3 | National Parks of Colombia | 1 |
| Secretariat of Mobility | 3 | Asocomunal | 1 |
| Medellín Metro | 3 | Private Secretariat of the Mayor's Office | 1 |
| Firefighters, Civil Defense, Red Cross | 3 | General Secretariat | 1 |
| Cornare | 2 | Ministry of Agriculture | 1 |
| Urban Curatorships | 2 | Landscape, Heritage and Public-Private Partnerships Agency | 1 |
| Inder | 2 | International Cooperation Agency (ACI) | 1 |
| Secretariat of Social Development | 2 | | |

Table 4.7: Actors involved in the management of green infrastructure and ecological structure, based on the regulatory review carried out.

4.5.1 Outcomes of the internal workshop with officials of the Mayor's Office of Medellín

On November 18, 2019, a workshop was held with officials of the Mayor's Office of Medellín, to which 56 professionals from the Secretariats with greater functions and competencies in the management of the green infrastructure and the ecological structure of Medellín were invited. The objective was to share the advances of the Re-naturalization Strategy and build proposals for the generation, maintenance and improvement of the green infrastructure and ecological structure of Medellín.

The workshop posed questions, developed discussions, and formulated observations and proposals around 4 major aspects, essential in the analysis of the management of green infrastructure and ecological structure, namely: Main functions and competencies, relations with other government actors, work instances, and proposals for institutional improvement for the governance of green infrastructure and the ecological structure of Medellín.

35 officials from 9 Secretariats and decentralized entities of the Mayor's Office of Medellín participated: Urban Development Company, Ministry of the Environment, Administrative Department of Planning, Ministry of Health, Secretariat of Management and Territorial Control, Ministry of Finance, Administrative Department of Disaster Risk Management,



Secretariat of Infrastructure, Agency for the Management of Landscape, Heritage and Public-Private Partnerships. In addition, 2 entities external to the Mayor's Office, although directly related to the management of urban and rural green: EPM and the Botanical Garden of Medellín.

Below are the main results, for each of the topics addressed.

4.4.4.1 Functions and competences

In relation to the functions and competencies, the participating Secretariats highlighted that they develop with greater emphasis tasks in relation to the conception and planning of projects and interventions (29.7%), formulation and design (19.2%), execution (15.2%), maintenance (14.0%), control and surveillance (11.3%), follow-up and monitoring (9.8%), and others (1.0%) (Figure 4.27).

In relation to the functions of formulation, design and implementation, a greater role of the Secretariat of Infrastructure and the EDU was highlighted, problems of operational segmentation of the functions (Secretariat of Infrastructure) that causes antagonistic criteria or difficulties for the implementation of plans and projects, and limitations of human resources for this group of functions. In general, it advocates greater integration between actors involved in the green public space, less resistance of environmental and administrative authorities to innovation, and greater recognition of technical capacities to achieve such articulation and innovation (EPM, JB JAUM, EDU).



Figure 4.27: Relative weight of the main functions and competences of all the Secretariats involved in the management of the green infrastructure and the ecological structure of Medellín.

In relation to maintenance, the main role of the Secretariats of Environment and Infrastructure was confirmed, with the main operational support of the Botanical Garden of Medellín. There are again needs for greater articulation and unification of criteria among the Secretariats, as well as budgetary and human team limitations for the performance of these functions.

In what corresponds to control and authority, most of the dependencies do not have or do not consider having that competence, beyond the custody of properties owned by the Municipality. The competence of control and authority is thus relegated to what the environmental authorities or the Secretariat of Management and Territorial Control carry out. Representatives of the environmental authorities did not attend, but the Secretariat of Territorial Management and Control points out operational and budgetary limitations to better exercise these functions: lack of inter-institutional regulations and competences, lack of motivation to exercise the functions, as well as problems of social indiscipline, lack of immediate action to correct incipient phenomena of misappropriation or destruction of green public space, fragmentation of competences that hinders the activity of restitution and recovery of public space, as well as the lack of visibility of these processes in development plans, at all scales.

Follow-up and monitoring were found to be to be the least representative block of functions of the efforts made by the Secretariats participating in the Workshop, which reveals a structural and strategic gap in relation to the management of green infrastructure and the ecological structure. The limited effort applied to this function implies ignorance of the impact and effectiveness of the intervention work carried out, which structurally prevents the knowledge management processes that must be at the basis of the conservation of the natural heritage of the city.

In the comments and observations of the officials of the Ministry of the Environment, two elements were explicit and reiterative: the lack of visibility, recognition and positioning of the aspects and competencies of planning in the tasks of the Secretariat, and the insufficiency of human and financial resources for these tasks. The Administrative Department of Planning, for its part, recognizes its work in the planning phase specifically in relation to the formulation and monitoring of the ecological structure as part of the POT, and also reveals limitations of specialized personnel for the fulfilment of their functions, a problem that also points out the Ministry of Health. The Secretariat of Infrastructure, for its part, mentions problems of articulation between the Secretariats and implementation and monitoring of the established plans (especially the Municipal Environmental Plan).

In conclusion, although not all government actors directly or indirectly involved in the management of green attended the working day, the figures clearly show an opportunity to better link strategic and operational tasks. A deeper and more detailed diagnosis and analysis of functions and competences could give a precise account of possible overlaps, redundancies, or gaps in the management of green infrastructure and ecological structure, to balance and articulate in an increasingly optimal and efficient way the administrative and technical burdens, strategic and operational necessary for its generation, maintenance and qualification.

4.4.4.2 Intra- and inter-institutional relations

With intra- and inter-institutional articulation and integration being a key element for the effectiveness of public management, the nature of relationships between actors was explored during the workshop. Each of the Secretariats or entities that participated in the Workshop



mentioned the actors in which they usually find determined support, conditional support, neutrality/indifference, or opposition. They were also proposed to detail the factors that facilitate/hinder such relationships with those specific actors.

The Ministry of the Environment (8 times), the Metropolitan Area of the Aburrá Valley (7 times), the Secretariat of Infrastructure (4 times), and the Botanical Garden of Medellín (4 times) were identified as the actors that offer the most decisive support. Another 19 entities were recognized in this list of actors that unconditionally support the action of the Secretariats and entities participating in the workshop. The factors that facilitate support are related to the interest or political will to give continuity to policies or programs, the availability of resources, the trust between the technical leaders of the processes, the affinity of focus in the actions, and the respect for the autonomy of the actors that interact.

The environmental authorities (Corantioquia + AMVA) and EPM, 3 times each, appeared as the actors with the greatest conditional support, followed by the Secretariat of Infrastructure, Botanical Garden and DAP (2 times each). Another 13 actors appear on this list. The factors that affect this conditioning have to do with the complementarity between competences and obligations of the actors that interact, the availability of personnel to work cooperatively, the availability of resources, and the existence or not of work tables or instances to exchange information.

Twelve (12) actors were identified as usually neutral or indifferent to the actions of the entities participating in the Workshop: National Police, Corantioquia, Territorial Control, Secretariat of Infrastructure, Secretariat of Security, Citizenship in general, Secretariat of Citizen Culture, and Secretariat of Inclusion, Comptroller, Guilds, Metropolitan Area of the Aburrá Valley, and Ministry of Finance. Among the factors that facilitate/hinder the relationship is the availability of personnel or resources, misinformation, or the fact of considering the actions irrelevant or impertinent.

Among the usually opposition actors were included only four (4): private citizen interests, illegal groups, Secretariat of Government and Territorial Control, and Ministry of Finance. The factors indicated as determinants of the opposition are the lack of information or knowledge, the invasion or friction of technical or administrative competences, territorial control (in the case of illegal actors), or the consideration of irrelevance of the initiatives.

4.4.4.3 Working groups

Subsequently, the exercise investigated the existing and active working bodies, in relation to the management of green infrastructure and ecological structure. During the exercise, 12 existing reference groups were identified:

- Forestry Committee
- SIGAM Committees (especially water resources, strategic ecosystems, habitat, air quality, climate change)
- Biodiversity Table
- Advisory Commissions and Technical Board DAGRD
- Cleaning and Decoration Committee



- POT Strategic Steering Council
- Climate Change Node
- Intersectoral Advisory Commission on Public Space
- Working Groups with Environmental Authorities
- Municipal Environmental Council
- Territorial Council for Environmental Health
- Accidental Commissions Council of Medellín

The means of documentation and systematization are mostly through minutes, and less frequently reports, concepts, plans, or other documentation. The Committee on Forestry was indicated as the most relevant, its high frequency (biweekly) is highlighted but the limitation is mentioned to make its concepts or recommendations binding. Another instance highlighted as very relevant are the Thematic Committees of SIGAM, although they are less active. Most of the instances have a monthly meeting periodicity, although some meet bimonthly or even semi-annually. All were considered by the participants to be of high relevance.

4.4.4.4 Proposals for improvement

Finally, as a result of the workshop held, an extensive list of proposals for institutional improvement was made by the attendees. This is included in Annex 2.

As a general overview of these proposals, the aspects related to the improvement of communication and socialization, internal and external of the actions carried out on urban and rural green are those most suggested (6 times), as well as the need and purpose of the work articulated between dependencies (5).

In relation to the institutional structure, divergent measures were proposed, such as creating a unifying management instance or entity (4), strengthening planning instances within each instance or secretariat (2), creating an instance attached to the Planning Department (1), the creation (strengthening, since it already exists, project-oriented) of an Inter-institutional Committee (1), or the strengthening of SIGAM (1).

The importance of increasing the number and skill of human resources for green management, the generation of green management policies or processes (2), the improvement of processes and information systems (2), and the formulation of plans with joint or common goals (2) was pointed out on 4 occasions. Essential aspects such as mechanisms for financing, and the need for teams dedicated to follow-up and monitoring or impact measurement were only pointed out 2 times, and the strengthening of territorial control only 1 time.

In the final part of the exercise, the following technical recommendations were made, some of which reinforce some of the needs raised in the proposals for institutional improvement:

1. Flagship species as natural indicators of the city, by zones.
2. Validate in the field the viability of the public space projected for ecoparks in the POT
3. Ensure sufficient and necessary resources for the maintenance of the new green public space.
4. Improvement of maintenance protocols according to the changes that exist.



5. As a starting point, appropriation of the issue of main ecological structure and its elements that make it up by all dependencies and officials. It is not to propose, for example, other ecological networks but to start from the one established in the POT to analyse their establishment and complement from the actions to be implemented from the different dependencies and institutions.
6. Creation of an administrative entity that handles the issue comprehensively and articulately
7. Define exclusive budget for the operation and implementation of a re-naturalization program
8. Take advantage of all urban projects (private and public) to generate and restore greening (vegetation cover, trees).
9. Clarify management of green walls and green terraces in terms of structures, health, and responsibility for maintenance.
10. Increase resources to investigate the problems of the urban green component
11. Inclusion of risk systems in new projects, to ensure greater adaptation and/or conservation of green areas.
12. Generate guidelines for the conservation of green infrastructure for the city, including those for the management and generation of green areas in public works.

4.5.2 Guidelines for intra-institutional articulation

Based on all the results and analysis of the methodological processes previously presented, the following guidelines for intra-institutional articulation are proposed as part of a re-naturalization strategy for Medellín:

- Elements are required to operationalize and specify the strategies proposed in the identified regulations. In this order of ideas, it is a priority to carry out detailed analyses that can lead to the definition of guidelines of mandatory applicability.
- An adequate articulation and intra- and inter-institutional coordination that allows to minimize the fragmentation of functions or to increase the unity of criteria around the planning and management of the green, especially in the Secretariats with greater influence in the matter: Environment, Physical Infrastructure, and Administrative Department of Planning.
- Generate assertive communication channels that from repositories of institutional information (via intranet), virtual courses for contractors and municipal officials, and institutional messages or permanent campaigns, promote the concrete, operational and instrumental elements that contribute to the management of green.
- Articulation and traceability with the regulations established in the POT around the management of green, which tends to the fulfilment of commitments and tasks in each of the Secretariats, and that are articulated around the common objective of planning and efficiently managing the green spaces of the city.
- Identification of problems and taking advantage of the strengths arising from the profusion of existing planning instruments, many of which are not regulated or if they are they do not get implemented for various technical, legal, political or financial reasons. In many of them there are opportunities for articulation and synergy that it is



necessary to value, for a more comprehensive planning and management of the urban landscape that incorporates all the dimensions of the urban and rural habitat and the expectations and needs of the communities. A fundamental role in this context seems to fulfil, in addition to the POT, the Climate Action Plan for Medellín in the process of formulation, the Medellín Environmental Plan that should be updated next year.

- Institutional will to define the operational channels to increase financing funds for the green infrastructure and ecological structure of Medellín. This would enable permanent financial, technical and operational resources to carry out the monitoring, follow-up and verification of the actions proposed by the regulations. In this sense, everything related to urban planning obligations and economic use of public space is strategic.
- It is fundamental for a strategy and plan of re-naturalization to think about the procedures and mechanisms of governance, as well as the elements of social control and institutional authority. It is essential to recover the confidence of citizens in government action for the management of green, and for this they must be reviewed, in conjunction with the Ministry of Government, the National Police, the Ministry of Education, the Secretariat of Citizen Culture, the Agency for the Management of Landscape, Heritage and Public-Private Partnerships, the Administrative Department of Planning, the Secretariat of Infrastructure, public service companies, and the urban environmental authority, the planning processes for the generation of urban green, as well as those for reporting environmental infractions, economic use of public space, among others on which the maintenance and conservation of existing spaces depends.
- It is necessary to strengthen and articulate the information and monitoring systems of the interventions carried out, and particularly, to evaluate the effectiveness of the projects, programs, and instances adopted through the different administrative acts, which allows to explicitly identify the successes, limitations, and obstacles presented, susceptible of being improved through various strategies and administrative, technical, and legal processes.
- All of the above can be detailed and concretized not only from Agreements or Decrees but also from Resolutions, Circulars, Concepts, Protocols, and Technical Sheets, which define or specify guidelines to enable and materialize the actions and procedures required to manage green spaces and encourage the implementation of Nature-based Solutions (NBS), feeding the technical dimensions, financial and governance necessary in the construction of the Medellín Renaturalization Plan.

4.5.3 Identification of Relevant and Priority Projects

Based on a reading of the formulation component of a series of planning instruments directly or indirectly related to the management of green infrastructure and ecological structure, convergent projects and programs were identified with the purposes of the Strategy, seeking potential synergies within the framework of a future Renaturalization Plan for Medellín.



4.5.3.1 Identification of planning instruments convergent with the re-naturalization strategy.

In order to find and develop opportunities for technical and financial integration of initiatives related to a Re-naturalization Plan, the programmatic components of 12 thematic or territorial plans of local or metropolitan scale were reviewed (

Figure 4.28).

As a result of this exercise, 499 projects related to the management of the green infrastructure and ecological structure of Medellín were identified, understanding management as the set of actions for planning, formulation, design, implementation, maintenance, follow-up and monitoring, and control and authority, implicit in their generation, maintenance, and qualification. Of these projects or initiatives, 167 have a high relevance to the strategy and the Re-naturalization Plan, due to a high coincidence with their interests and objectives. Of these 167 initiatives, 21 have a moderate level of detail in their structuring and conception, so they could be considered as a priority for pilot implementation or development exercises. The rest are raised only in a superficial or schematic way, but they could be fundamental in the necessary convergence of human and economic resources for the re-naturalization of Medellín, from a more synergistic and effective intra- and inter-institutional action, simultaneously attending to diverse sectoral objectives.



Figure 4.28: Local and Regional Planning Instruments Related to a Re-naturalization Strategy for Medellín

The plans with the largest number of convergent actions with the purposes of a Re-naturalization Plan, and that due to their thematic affinity or operational connection must be considered strategically in their formulation process, are presented in Figure 4.29.

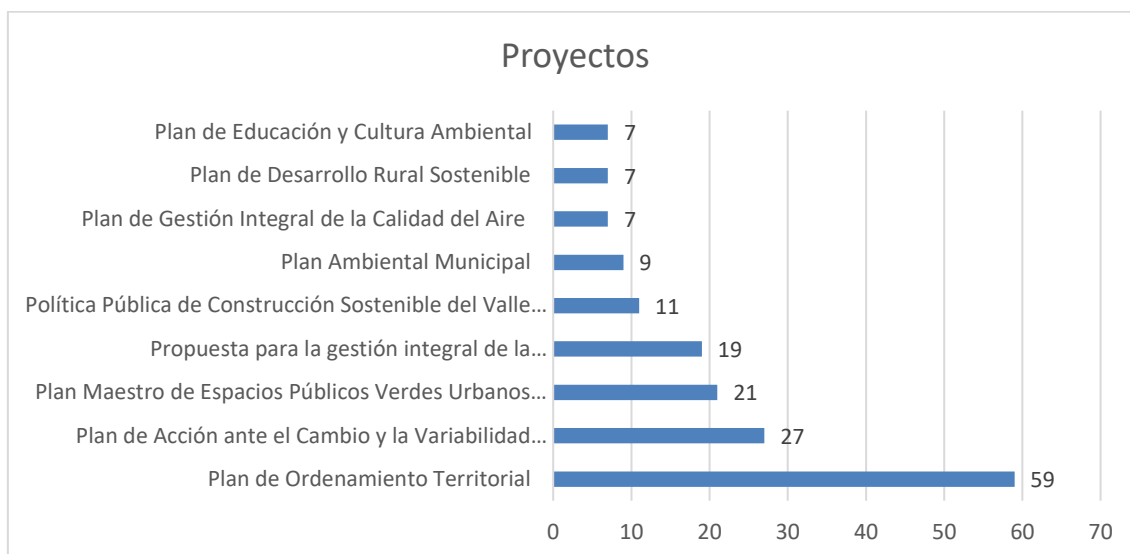


Figure 4.29: Number of convergent projects with a Re-naturalization Plan in the main territorial and sectoral planning instruments of Medellín and the Aburrá Valley

The projects with the greatest affinity to a RUP and plan fall within the following topics, intentions and typologies:

- Adoption of plans or regulations
- Appropriation of public space
- Qualification of green spaces
- Environmental performance of agricultural systems
- Design and implementation of incentives
- Eco-weeds and food safety
- Environmental education
- Energy efficiency in buildings and infrastructures
- Studies and research
- Formulation of plans and projects
- Strengthening of administrative bodies
- Strengthening ecological networks
- Generation and management of public spaces
- Generation and maintenance of physical infrastructure and equipment
- Risk management
- Management and financing instruments
- Management of public spaces
- Management of green spaces in ecological networks
- Vegetation maintenance
- Citizen participation and governance
- Preservation of flora and forests
- Protection of creeks and catchment
- Recreation and tourism
- Recovery of public space
- Recovery and management of degraded areas
- Environmental health
- Information and management systems
- Economic valuation
- Surveillance and control

4.6 NBS for Medellín

4.6.1 Existing NBS

Prior to the commencement of URBAN GreenUP, a number of NBS had already been planned and were under development or had been delivered in Medellín. Green corridors associated with roads, urban parks, ravine ecoparks, green walls, urban eco-gardens and gardens were all implemented by the city. These are called early implementations, which are constituted as part of the range of local NBS, necessary for the greening of the city, which in turn could be interpreted as part of the measures that the city welcomes to respond to adaptation and mitigation to climate change and the search for actions that can improve air quality. Here it is discussed the NBS implemented by the city of Medellín in the municipal administration 2016-2019.

4.6.1.1 *Green corridors and urban parks*

The ecological and spatial articulation of the city centre with its surroundings has been raised through thirty urban corridors with characteristics and conditions of environmental improvement, where the planting of more than 15 thousand trees, plant surfaces and natural floors was proposed. An intervention project in 40 parks in the centre of Medellín articulates them with the urban space through environmental walks with pedestrian priority and non-motorized mobility. These spaces, recognized as neighbourhood centralities that attract families and visitors, where some of the most representative institutions of the city have been staying for several years, are part of the ecological network that is articulated with the hills, with the urban structure, with the heritage and with the natural components.

Within what is identified as urban green infrastructure for Medellín, green corridors are a fundamental role, especially those associated with water resources, which are widely recognized for their high potential to favour connectivity between the different fragments and nodes that constitute the Main Ecological Structure (EEP) and that in turn, are typified as part of the Public Space (EP) of the city, as well as the supply of ecosystem goods and services associated with them.



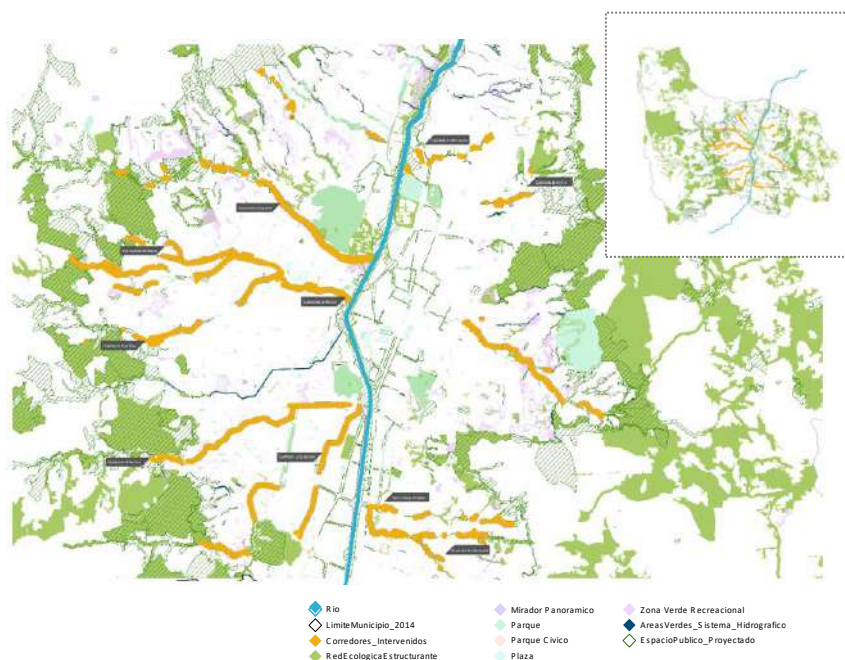


Figure 4.30: Urban Green Corridors in Medellín

In context, the urban green corridor projects, are mainly concentrated towards the western slope, with a greater number of square meters in the laureles-Estadio, La América, Belén and Guayabal communes. These corridors are associated with the Altavista, Ana Díaz, Bermejala, El Molino, La Guayabala, La Hueso, La Iguaná, La Pelahueso, La Poblada, La Presidente, Malpaso, Bonilla or Pela Hueso and Santa Elena streams.

The 13 urban green corridors intervened are concentrated mostly on current links of the Main Ecological Structure (EEP) with a total of 304,179.04 m² representing 53% of the total area intervened on the EEP, followed by 28,776.44 m² for 5% on fragments and, 2% and 1% respectively on links and projected nodes.

Most of the areas in the corridors are identified in Article 69 of Agreement 048 of 2014 – POT of Medellín under the category of Ecopark, which are part of the Subsystem of Public Space Recreation Existing Meeting, defining them as a public space constituted by elements of nature where it is intended to maintain biodiversity, conservation and restoration of the ecosystem, therefore public access and enjoyment of its natural values is conditioned to passive recreation, contemplation, leisure and citizen encounter.

Finally, it is estimated that the total number of trees planted in the corridors reaches about 15,000 individuals of different species; however, the officially supplied cartographic source records a total of 944 trees planted, which were distributed throughout the 13 corridors intervened as of December 2018, according to the base information.

Table 4.8 allows us to observe the relationship of the square meters intervened by each corridor and the total number of tree individuals established or planted.

| RUNNER | INTERVENTION TO 2018 | | TREES PLANTED | |
|-------------------------|----------------------|-------------|-----------------------|-------------|
| | m ² | % | Number of Individuals | % |
| Altavista | 5543 | 15% | 1156 | 14% |
| Ana Díaz | 1521 | 4% | 569 | 7% |
| Bermejala | 165 | 0% | 84 | 1% |
| The Mill | 314 | 1% | 82 | 1% |
| La Guayabala | 9235 | 24% | 1845 | 23% |
| La Bone | 6085 | 16% | 1580 | 19% |
| La Iguaná | 9612 | 25% | 1508 | 18% |
| La Pelahueso | 1451 | 4% | 404 | 5% |
| El Populated | 576 | 2% | 112 | 1% |
| El President | 1500 | 4% | 361 | 4% |
| Malpaso | 117 | 0% | 54 | 1% |
| Bonilla or PelaHueso | 383 | 1% | 134 | 2% |
| Saint Helena | 1619 | 4% | 281 | 3% |
| Total (2018) | 38121 | 100% | 8170 | 100% |

Source: Ministry of Environment of Medellín (2018)

Table 4.8: Number of Trees Planted in the Intervened Corridors Identified in 2018

It is of great importance to identify at present the established species and the total number of them to estimate the ecosystem services associated with them, and to ensure over time, their timely maintenance through relevant silvicultural practices, given the needs to ensure improvements in both the air quality of the city and the metropolitan region in general; as well as in those territorial and environmental capacities that allow a better quality of life considering the dynamics of the generation, conservation and maintenance of urban green areas and their associated ecosystem goods and services aimed at mitigation and adaptation to climate change. It is expected that the aforementioned corridors and all those spaces that are part of the green infrastructure of the city can be measured as responses into the nine challenges identified in the RUP through state indicators (KPIs).

The success of the program of green corridors is discussed further in Annex 3. A case study of the underlying spatial Planning approach is considered in Chapter 6 (Territorial Prioritisation).

4.6.1.2 Green walls and gardens

This Nature-based Solution (NBS) has been led by the Ministry of the Environment since 2017. The first 4 green walls were installed, during 2018 they were increased to 15 walls, that is, 11 more, reaching 20 so far in 2019. Of these, 15 (that correspond to 75%) are associated with the road network, particularly those parallel to the metro viaduct, seeking to generate an efficient irrigation system that depends on the water that filters through the infrastructure of the



viaduct itself, and/or on any of the subcategories of the existing public leisure and meeting space defined by Agreement 048 of 2014 such as squares, parks, squares, among others.



Figure 4.31: Example of a green wall in Medellín

Most of the green walls are located in the Commune 10 - La Candelaria with 35%, particularly concentrated in the vicinity of the Administrative Centre La Alpujarra: the Mayor's Office of Medellín, the depressed Av. San Juan, Av. Ferrocarril, the Palace of Justice and Plaza Mayor. 20% in the commune 14 – El Poblado in places like roundabout Station Aguacatala, the road interchange Loma de Los Parra and in the road interchange bridge the Four South and. For the communes 2, 3 and 4 (Manrique, Santacruz and Aranjuez) a green wall was installed in each one. The total distribution is shown in Table 4.9.

| COMMUNE / PLACE / NRO. GREEN WALLS INSTALLED | | | |
|---|---|--|---|
| Aranjuez | 1 | Laureles Stadium | 3 |
| HOSPITAL STATION METRO VIADUCT | 1 | SOUTH AMERICAN STATION METRO VIADUCT TO MACARENA | 1 |
| The Village | 4 | CARRERA 73 METRO VIADUCT AND ATANASIO STADIUM WALL | 1 |
| GLORIETA ESTACION AGUACATALA | 2 | VIADUCT METRO STADIUM OF CARRERA 70 | 1 |
| LOMA DE LOS PARRA ROAD INTERCHANGE | 1 | Manrique | 1 |
| ROAD INTERCHANGE PUENTE LA CUATRO SUR | 1 | ECOPARK EL MOLINO | 1 |
| La Candelaria | 7 | Santa Cruz | 1 |
| MAYOR'S LY | 1 | VILLA DEL SOCORRO | 1 |
| RAILWAY AVENUE BY METROPLUS OF PLAZA MAYOR | 1 | The America | 1 |

| | | | |
|--|---|-------------------------------|---|
| DEPRESSED SAN JUAN ALPUJARRA | 1 | SAN JAVIER AND CEDEZO LIBRARY | 1 |
| GLORIETA DE LA 33 WITH AVENIDA FERROCARRIL | 1 | LA HUESO ECOPARK | 1 |
| PALACE OF JUSTICE | 1 | Corregimiento Altavista | 1 |
| PLAZA MAYOR | 2 | ALTAVISTA GOVERNMENT HOUSE | 1 |

Source: Ministry of Environment of Medellín (2019)

Table 4.9: Identification of the sites where the green walls have been installed in Medellín as of 2019

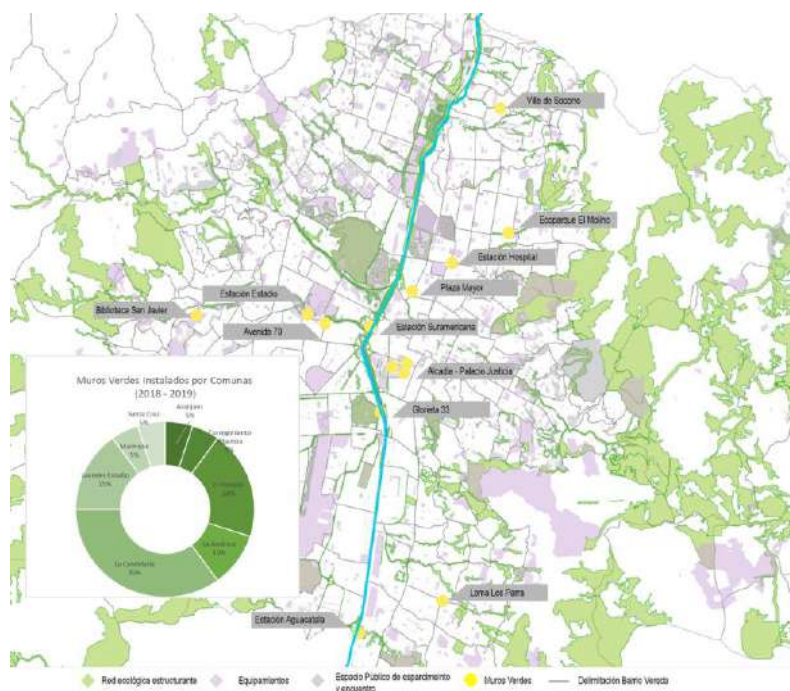


Figure 4.32: Green walls in Medellín

In some cases, they are associated with the green walls, concentrating mostly in the commune 10 – La Candelaria (57%), around the Administrative Centre La Alpujarra, the roundabouts of San Juan and Exhibitions, as well as in 30 other sites. Communes 4, 11 and 14 (Aranjuez, Laureles and El Poblado) have 17%, 10% and 6% of square meters installed respectively. Only communes 2, 3 and 6 (Santa Cruz, Manrique and Doce de Octubre) do not have gardens installed according to the records of the available information.

| | Aranjuez | Bethlehem | Castile | San Cristobal* | St. Helena* | The Village | Guayabal | The America | La Candelaria | Laureles Stadium | Popular | Oak wood | San Javier | Beautiful Villa |
|----------------|----------|-----------|---------|----------------|-------------|-------------|----------|-------------|---------------|------------------|---------|----------|------------|-----------------|
| m ² | 18627,55 | 2356,58 | 2513,11 | 709,14 | 3556,06 | 34488,7 | 6287,46 | 1071,34 | 112446 | 11988,43 | 740,81 | 3077,77 | 498,02 | 372,36 |
| % | 9,4 | 1,20 | 1,30 | 0,40 | 1,80 | 17,40 | 3,20 | 0,50 | 56,60 | 6,00 | 0,40 | 1,50 | 0,30 | 0,20 |

Table 4.10: List of gardens installed by commune (m²) to 2019. Source: Ministry of Environment of Medellín (2019)



amortization, which indicates that the investment will not be recovered); Likewise, within the description of each solution, the impact it would have on each of the challenges and the success stories that have been registered is described.

4.6.3 Conceptual model for future NBS selection

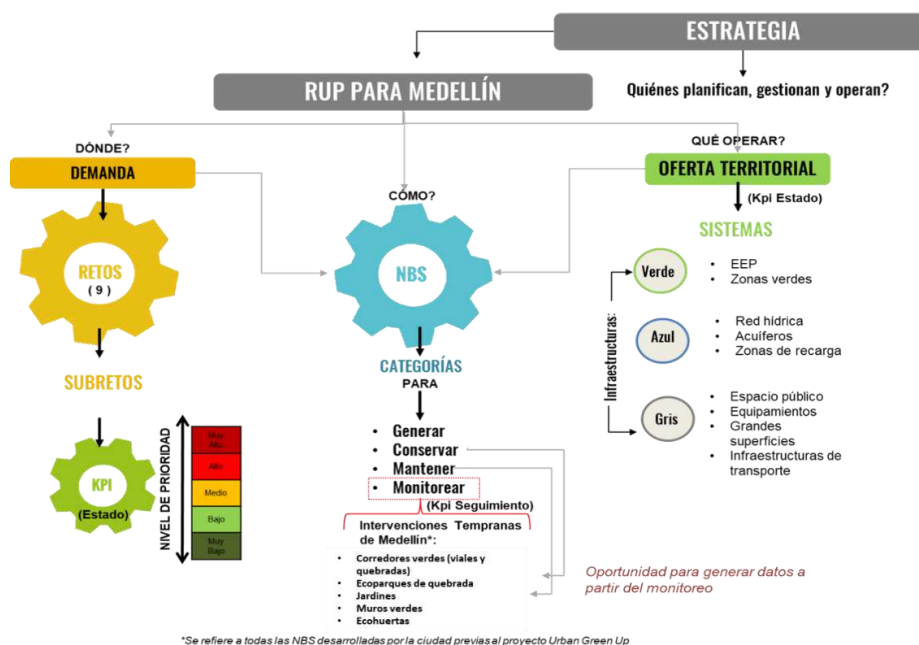


Figure 4.34: Model proposed for NBS selection to support formulation of the Medellín RUP

A conceptual model was built that relates the strategy of Re-naturalization - phase 2 and which is required for the formulation of the RUP. This model refers to how can we spatialize the NBS in the territory. This approach indicates who are the ones who plans, manages and maintains the green in Medellín and delivers the initial inputs for the construction of the RUP.

The above diagram shows the proposed model, which is based on key questions such as:

WHERE? will NBS be prioritised, **ON WHAT?** infrastructure, **HOW?** we intervene or monitor and finally **WHO?** plans, manages and operates the NBS of a RUP.

After identifying the priority and the territorial offer in earlier chapters, the most relevant NBS are defined according to the relationship **NBS = PRIORITY + OFFER**, that is, the categories of the NBS function as a "toolbox" that are designed as strategies for adaptation and mitigation to climate change and must meet the greatest number of challenges and make the most of the local territorial offer.

From this perspective, it is necessary to relate 12 sub-challenges which emerge from the **5 instrumental challenges** identified in Chapter 1 (these being climate change, water management, green and blue space management, urban regeneration and air quality) as classified proposed in the initial prioritization exercise, with the categories of the NBS that have the capacity to solve the problems associated with each challenge, understanding that each



solution based on nature requires a territorial infrastructure that supports it. This is elaborated further in the following chapter, which outlines the model for territorial prioritisation of NBS.

4.6.4 NBS Prioritized

For the prioritization of the typologies of Nature-based Solutions in the city of Medellín, several criteria were met:

- Feasibility of implementation according to geographical context: geomorphological structure and hydrological structure.
- Sustainability process of the solution based on nature over time and its relationship with the cost of implementation and maintenance.
- Relationship with the territorial model of the municipality of Medellín and responsibility for institutional implementation.
- Institutional commitment at the public and private level with the Re-naturalization strategy in the construction and implementation phase, which has a direct relationship with the availability of human and budgetary resources.

Taking into account the above criteria, the following typologies were prioritized, where those with the greatest potential to be developed by the different institutions that are articulated with the Ministry of Environment of Medellín are focused, as the governing body of the project; Additionally, the typologies of solutions based on nature that the Institute of Sport and Recreation of Medellín INDER has been developing are presented, as early interventions.

| N° | TYPOLOGY | ENTITY |
|----------------------------|---|--|
| BLUE INFRASTRUCTURE | | |
| <i>Flood Areas</i> | | |
| 1 | Urban forest catchment areas | SECRETARY OF THE ENVIRONMENT OR OTHER ENTITIES |
| 2 | Flood park | SMA-INDER |
| 3 | Hard Drainage Flood Prevention Dig Up Waterways | SECRETARY OF THE ENVIRONMENT OR OTHER ENTITIES |
| 4 | Re-naturalization of channels | SECRETARY OF THE ENVIRONMENT OR OTHER ENTITIES |
| <i>Sustainable drains</i> | | |
| 5 | Rain gardens | SMA-INDER |
| 6 | Sustainable drainage system | SMA-INDER |
| <i>Water Treatment</i> | | |



| | | |
|---------------------------------------|-----------------------------------|--|
| 7 | Green filter area | SECRETARY OF THE ENVIRONMENT OR OTHER ENTITIES |
| 8 | Natural wastewater treatment | SECRETARY OF THE ENVIRONMENT OR OTHER ENTITIES |
| GREEN INFRASTRUCTURE | | |
| <i>Rest areas</i> | | |
| 9 | Green rest areas | SMA-INDER |
| 10 | Pocket parks | SMA-INDER |
| <i>Vertical green infrastructures</i> | | |
| 11 | Green barriers to mitigate noise | SMA-INDER |
| 12 | Green fences | SMA-INDER |
| 13 | Green cover Refying | SMA-INDER |
| 14 | Green facades with vine plants | SMA-INDER |
| <i>Green pavements</i> | | |
| 15 | Cold pavement | SECRETARY OF THE ENVIRONMENT OR OTHER ENTITIES |
| 16 | Bicycle-pedestrian-green pavement | SECRETARY OF THE ENVIRONMENT OR OTHER ENTITIES |
| 17 | Permeable pavements | SECRETARY OF THE ENVIRONMENT OR OTHER ENTITIES |
| 18 | Green pavements and parking lots | SECRETARY OF THE ENVIRONMENT OR OTHER ENTITIES |
| 19 | Green cycle-pedestrian routes | SECRETARY OF THE ENVIRONMENT OR OTHER ENTITIES |
| GREY INFRASTRUCTURE | | |
| <i>Urban agriculture</i> | | |
| 20 | Composting | SMA-INDER |



| | | |
|-------------------------------------|---|--|
| 21 | Small-scale urban livestock | SECRETARY OF THE ENVIRONMENT OR OTHER ENTITIES |
| 22 | Urban orchards | SMA-INDER |
| 23 | Greenhouses | SECRETARY OF THE ENVIRONMENT OR OTHER ENTITIES |
| <i>Carbon capture</i> | | |
| 24 | Urban carbon sinks | SMA-INDER |
| <i>Smart floors</i> | | |
| 25 | Soil improvement and nutrient release | SMA-INDER |
| <i>Contaminant filters</i> | | |
| 26 | Green filter areas | SECRETARY OF THE ENVIRONMENT OR OTHER ENTITIES |
| 27 | Planting and renovation of urban trees | SMA-INDER |
| <i>Tree interventions</i> | | |
| 28 | Tree zones around urban areas | SMA-INDER |
| 29 | Trees in parking lots | SMA-INDER |
| 30 | Shade trees | SMA-INDER |
| <i>Pollinators</i> | | |
| 31 | Berms and spaces for nearby pollinators | SMA-INDER |
| 32 | Walls for pollinators | SMA-INDER |
| 33 | Natural pollinator modules | SMA-INDER |
| 34 | Trees for cooling | SMA-INDER |
| 35 | Green roof for pollinators | SECRETARY OF THE ENVIRONMENT OR OTHER ENTITIES |
| <i>Other Special Inder Handling</i> | | |
| 36 | Mixed walls, graffiti management | INDER |
| 37 | Landscape management of slopes | INDER |

Table 4.11: Prioritized typologies of NBS



4.7 Territorial prioritization model for the application on NBS

This chapter describes the model of spatial prioritisation of NBS delivery that is central to this RUP. This is referred to as the Territorial Prioritisation Model.



Figure 4.35: Document structure of the Territorial Model for the Medellín Re-naturalization Plan

Figure 4.35 presents the structure of the document of the Territorial Model of the Re-naturalization Plan for Medellín (RUP) that is based on the conceptualization and methodological approach represented in Figure 4.36. In this sense, the plan recognizes nine city challenges proposed from the UGU methodology. These challenges address global problems directly related to climate change and its different consequences, as well as strategic points to consider for its adaptation and mitigation.

These challenges are interpreted as a demand of the city. The result of the challenges must be considered a spatial representation that can be interpreted from the municipal administration, which is why it is of vital importance to spatialise this information both in communes, neighbourhoods and specific sectors to determine the criticality of these challenges in forceful areas of Medellín.

After having the overview of the state of the challenges and the areas with the greatest problems of the city, it is important to identify the areas on which public or private entities can act to face the problems, considering the blue, green and grey infrastructures (categories proposed by the UGU) as the offer to address the demand of the problems and an opportunity to intervene in the areas most affected by the over position of challenges. This territorial offer must be considered in the context of the Municipal System of Territorial Planning, specifically the Physical-Spatial System to have a direct articulation with the agreement 48 of 2014, in addition to articulating with the multiscale strategy proposed by the Forestry Manual in order that the interventions carried out in specific elements of the green infrastructure, blue or grey have an impact on the city system and really contribute to the established challenges.

Having clear the demand for problems through the challenges and the territorial offer from the infrastructures as an opportunity to intervene and face the problems, it is necessary to identify the catalogue of solutions that can be applied in said infrastructure. In this sense, an inventory of NBS proposed by the UGU is identified, in addition to other actions considered as

early interventions of Medellín such as green walls, orchards, ravine parks, green corridors and other interventions that are perfectly comparable with the catalogue proposed by the UGU. For this inventory of NBS, some interventions enunciated in the Manual de Espacio Público de Medellín are also considered. For the NBS collected from the different sources, the capacity of each of these for the provision of ecosystem services is established. In this way, an inventory of NBS is consolidated where those that offer a greater number of ecosystem services can be identified.

Having clear the problems through the challenges of the city, the territorial offer as an opportunity and the NBS as a solution to the problems, it is necessary to articulate the three components: Challenges, Infrastructure and NBS in order to identify on which infrastructures NBS can be applied to solve the problems. For this purpose, the infrastructures are classified in relation to the challenges, that is, it is identified which of the infrastructures contain a greater number of overlapping challenges. In this way these infrastructures are prioritized as areas with the greatest problems. On the other hand, the infrastructures where the different categories of NBS can be applied are identified, recognizing which are the NBS that can be replicated the most and which are the infrastructures that can assume a greater variety of NBS.

After identifying the challenges of the city, the territorial offer, the NBS with the ecosystem services they provide and the articulation between these three components, the territorial model of the RUP proposes to identify the priority areas for NBS delivery in the city due to the over position of challenges, the infrastructures that are in these areas and the NBS that can be applied in these infrastructures. In this way, Nature-based Solutions are the answer to meet the challenges of the city through infrastructures as a territorial system, seeking a result with a multiscale impact.

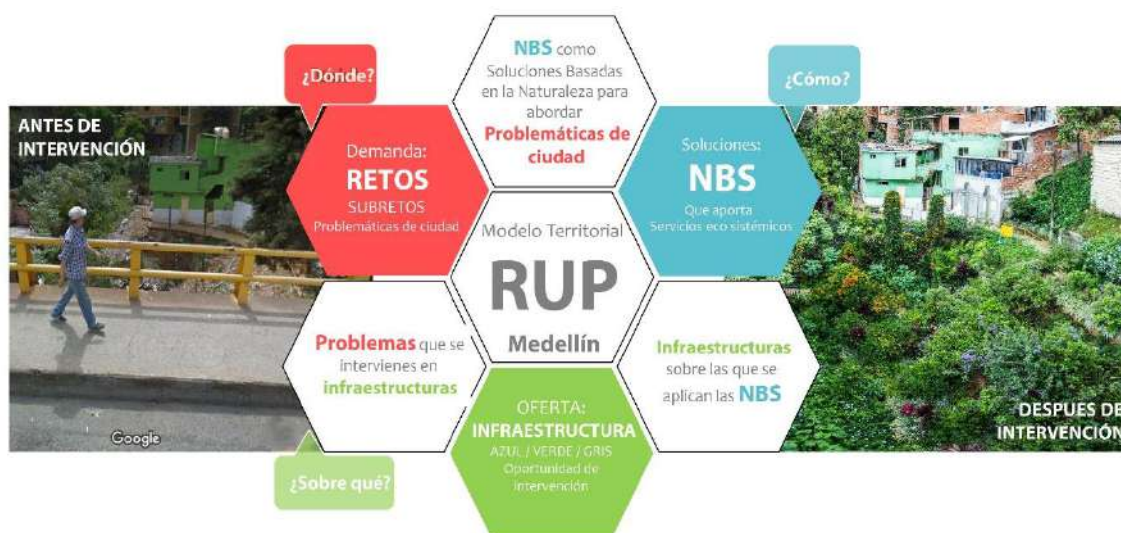


Figure 4.36: Conceptual structure of the Territorial Model for the Medellín Re-naturalization Plan

4.7.1 Analysis of challenges, city problems

4.7.1.1 City challenges

Medellín has opted to address nine challenges and (26) specific sub-challenges (hereafter termed *subretos*), four of them non-spatializable and that need to be analysed in the light of the management model and the financial strategy of the RUP to determine the most efficient way to quantify them. The table relates the total of challenges and *subretos* associated with these, likewise, it aims to indicate the relationship of the different institutional actors in relation to the source of information of each *subreto* used for the analysis that will be raised in the following numerals of this document and, therefore, represents an overview of those strategic alliances that the territorial model will require in the future for possible updates of the same.

| CHALLENGE | SUBRETO | INDICATOR | FOUNTAIN | YEAR | INSTITUTIONAL ACTOR |
|--|------------------------------|---|----------------------------------|-----------|--|
| R1: Adaptation and Mitigation to Climate Change | | | | | |
| | 1.1: Adaptation | Surface Temperature / Urban Heat Island (ICU) | Secretary of Health | 2018 | SIATA - AMVA - PAC |
| | 1.2: Mitigation | Normalized Difference Vegetation Index | PGIBSEM | 2013 | SIATA - AMVA - PAC |
| R2: Water Management and Management | | | | | |
| | 2.1: Water Quality | Dumping Density | POMCA | 2017 | EPM - Number of discharges |
| | 2.2: Water reuse | Sectoral demand water | POMCA | 2017 | POMCA - EPM |
| | 2.3: Water scarcity | Aridity Index | POMCA | 2017 | POMCA |
| | 2.4: Floods | Flood risk | POT | 2015 | DAGRED |
| R3: Management of green and blue spaces | | | | | |
| | 3.1: Ecological Connectivity | Presence of EEP elements | Ecological structure POT - PEMOT | 2014-2018 | Ministry of Environment and Secretariat of Planning (Environmental Team) |
| | 3.2: Ecological Diversity | Diversity of urban trees | Urban Tree System (SAU) | 2019 | Ministry of the Environment (SAU team) |
| | 3.3: Ecosystem Services | Density of green areas | Inventory of AMVA green areas | 2019 | Ministry of Environment and Secretariat of Planning (Environmental Team) |
| R4: Air quality | | | | | |
| | 4.1: Air | ZOVSA Air | Ministry of Health | 2019 | AMVA |



| CHALLENGE | SUBRETO | INDICATOR | FOUNTAIN | YEAR | INSTITUTIONAL ACTOR |
|--|---|--|--|------|--|
| | 4.2: Noise | ZOVSA noise | Ministry of Health | 2019 | AMVA |
| R5: Sustainable Urban Development | | | | | |
| | 5.1: Urban treatments | Areas of renovation, development and integral improvement treatments | POT | 2014 | DAP |
| R6: Participatory planning and governance | | | | | |
| | 6.1: Environmental prevention | Density of training on environmental issues | Secretary of the Environment | 2019 | SMA |
| | 6.2: Integrated green management | Density of green projects | Secretary of the Environment | 2019 | SMA |
| | 6.3: Citizen identity / Meeting spaces | Density of effective public spaces | POT | 2014 | DAP |
| R7: Justice and social cohesion | | | | | |
| | 7.1: Capabilities | Density of environmental complaints – PQRS (Petitions, complaints, claims, suggestions and environmental complaints) | Environmental Complaints AMVA - PQRS | 2018 | Ministry of the Environment |
| | 7.2: Distribution | Density of m3 built | Cadastre - POT | 2014 | SIF |
| | 7.3: Procedures / Genuine Inclusion | Crime density | Secretary of Social Security MED - DATAMED | 2019 | SIF |
| | 7.4: Recognition of different social groups | Density of actors | JAC | 2019 | Ministry of the Environment |
| R8: Welfare and public health | | | | | |
| | 8.1: Reducing risks in vulnerable communities | Areas of threat from mass movement and fires | The Municipal Disaster Risk Management Plan (PGRM) | 2015 | DAGRED |
| | 8.2: Encourage physical activities | Density of the pedestrian network and bicycle route network Density of crime | AMVA Destination Origin Survey | 2017 | Secretariat of Physical Infrastructure |



| CHALLENGE | SUBRETO | INDICATOR | FOUNTAIN | YEAR | INSTITUTIONAL ACTOR |
|--|---|---|---------------------|------|---|
| | 8.3: Mental health and well-being | Density of diseases related to climate change | Secretary of Health | 2019 | Ministry of Health |
| R9: Economic potential opportunities and green jobs | | | | | |
| | 9.1: Cooperation between multiple parties | To be identified | | | To be identified from the financial strategy and management model of the RUPM |
| | 9.2: Financial incentives | Change in the mean or median value of land and property | | | |
| | 9.3: Legislation and policies for NBS | To be identified | | | |
| | 9.4: Planning procedures | To be identified | | | |

Table 4.12: Challenges and sub-challenges (*subretos*) considered in the Territorial Prioritisation Model

4.7.2 Information for the representation of challenges and *subretos* in Medellín

Climate change adaptation and mitigation

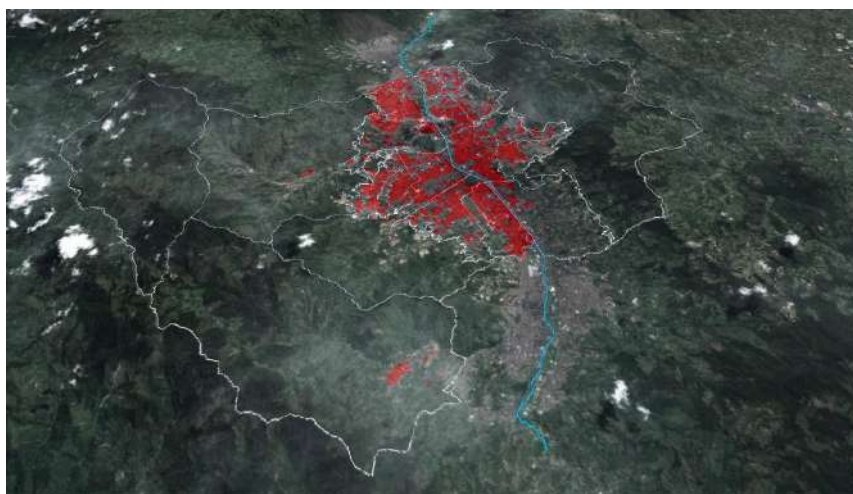


Figure 4.37: Synthesis Challenge 1, adaptation and mitigation to climate change

The increase in temperature in the Aburrá Valley has had an average increase of 4.81 degrees Celsius, having points where these changes reach up to 6.23 degrees. Some areas have come to transform up to 83% of their vegetation into impermeable soil. It is in this sense that the increase in temperature is the result of the transformation of the vegetal layer of the city and the imbalance in some areas of the built areas with the green areas that is evidenced from the

felling of trees for the implementation of new urban infrastructures to the change of permeable soils to impermeable soils by individual actions of the citizens, as well as the density and materiality of the buildings.

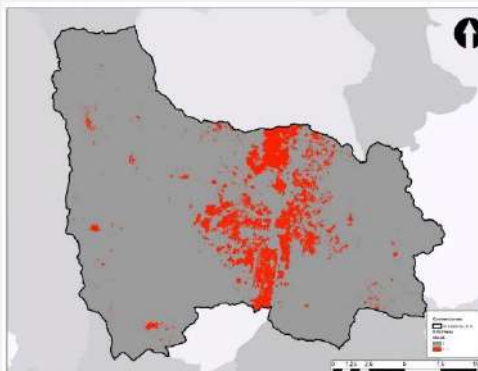
These urban interventions can be re-naturalized with Nature-based Solutions, in the same way the new interventions can be projected from the beginning taking into account the ecosystem services provided by the natural elements and conditions of habitability that improve the quality of life of citizens.

R1: ADAPTATION AND MITIGATION TO CLIMATE CHANGE

SR1.1: Adaptation

Indicator: Surface Temperature / Urban Heat Island (ICU)

Increase of 4.81°C between 1986 and 2016.

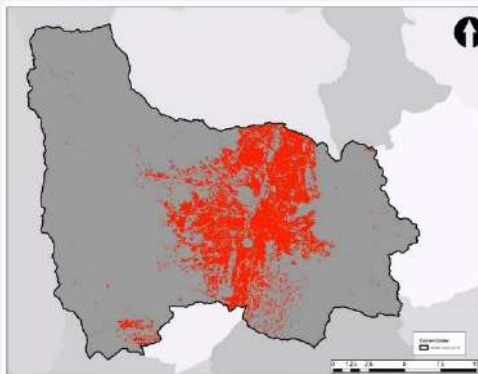


Source: Action Plan for Climate Change and Variability PAC&VC 2018 – 2030 (partial results as of November 2019)

SR1.2: Mitigation

Indicator: Normalized Difference Vegetation Index

Loss of vegetation of up to **83%** in some neighbourhoods between 1986 and 2015.



Source: Action Plan for Climate Change and Variability PAC&VC 2018 – 2030 (partial results as of November 2019)

Water Management



Figure 4.38: Synthesis Challenge 2, water management

Taking into account the 4,498 illegal discharges directly to water sources, it is necessary to identify the areas where these are carried out, in addition to relating to the more than 11,000,000 m² of the city that are in flood areas. This relationship of information can allow to generate areas of drainage and direction of water, foreseeing infrastructures for flood areas that function as points of water collection for different activities, such as the reuse of water in the different economic sectors such as industry or livestock activities that are those that take the largest amount of water resource directly from the sources or to maintain the flow of water sources in the most important times.

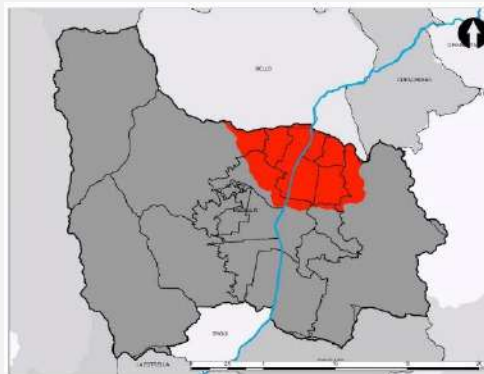
| R2: WATER MANAGEMENT AND MANAGEMENT | |
|---|--|
| <p>SR2.1: Water Quality</p> <p>Indicator: Discharge Density</p> <p>4,498 illegal dumping of water sources</p> | |
| <p>Source: POMCA Río Aburrá - EPM 2014</p> | |
| <p>SR2.2: Water reuse</p> <p>Indicator: Sectoral water demand</p> <p>4 basins are identified where the reuse of water resources is important for the sectors:</p> <p>Agricultural industrial livestock</p> <p>Recreational</p> | |

Source: POMCA Río Aburrá - EPM 2014

SR2.3: Water scarcity

Indicator: Aridity Index

Of the **15 micro-basins** of Medellín in the Aburra River, **2 basins** have a low level of **aridity**

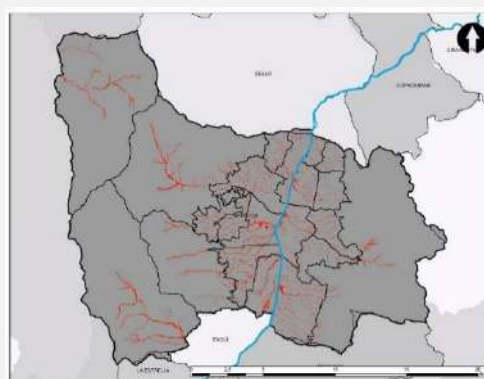


Source: POMCA Río Aburrá - EPM 2014

SR2.4: Floods

Indicator: Flood risk

Approximately **1,145 ha** equivalent to **3%** of the city's territory presents a high risk of **flooding**



Source: Agreement 048 of 2014- Medellín Risk Management Plan

Management of Green and Blue Spaces



Figure 4.39: Synthesis Challenge 3, Green and blue space management

This challenge refers to the existence, planning and management of blue and green infrastructure for the city, such infrastructures include natural or semi-natural elements that provide ecological and socioeconomic benefits for the inhabitants; Therefore, green areas, urban trees and the ecological network play a fundamental role for Medellín, offering ecosystem services and contributing to the mitigation of climate change. In this sense, it is the

areas devoid or equipped with restrictions against these elements that are prioritized to favour the implementation of solutions based on nature.

Within the urgencies of the city, the generation, conservation, maintenance and monitoring of spatial elements that contribute to the strengthening of connectivity and the supply of ecosystem goods and services in the city is identified.

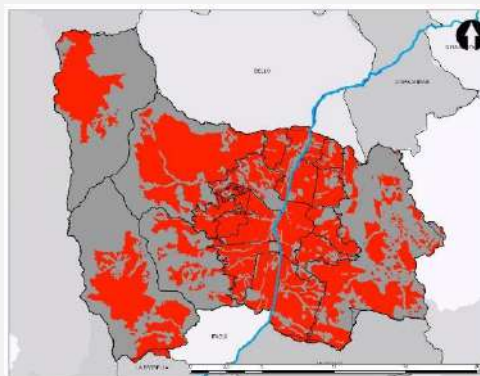
R3: MANAGEMENT OF GREEN AND BLUE SPACES

SR3.1: Ecological Connectivity

Indicator: Area of influence of the ecological network

20% of the city corresponds to current elements of the ecological network.

49% of the municipal territory presents levels of fragmentation with **distances greater than 36 meters.**



Source: Agreement 048 of 2014

SR3.2: Ecological Diversity

Indicator: Diversity of the urban tree

40,974 of the trees reported belong to **637** different species.

The most common species are **mangoes, yellow guayacanes, urapans.**



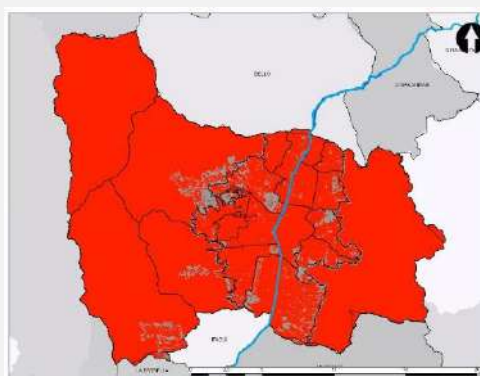
Source: SAU. Urban Tree System of the City of Medellín 2019

SR3.3: Ecosystem Services

Indicator: Density of green areas

Urban green areas occupy **4.4%** of Medellín.

It is associated with public space by **2.2%**, roads by **0.6%** and streams by **1.6%**.



Air Quality



Figure 4.40: Synthesis Challenge 4, Air Quality

This challenge, compared to the others, has presented some difficulties in achieving its territorialization, which is why the RUPM technical team spatializes it from the available information that refers to the susceptibility of vegetation cover fire (SIATA source) to which the Areas Subject to Environmental Health Surveillance (ZOVSA) of the Air prioritized by the Ministry of Health were associated, since the gases released by such events directly contribute to the deterioration of air quality.

Likewise, the density of noise complaints reported in the city (source Ministry of Health), were considered given the serious effects on human health and biodiversity, these coincide with the ZOVSA of noise. Analysis on this topic is ongoing.

| R4: AIR QUALITY | |
|--|--|
| SR4.1: Emission of gases by fire | |
| Indicator: Area with highest probability of vegetation cover fires | |
| 70.26Km2 of the city have susceptibility to vegetation cover fires and / or are catalogued by the Ministry of Health as Areas Subject to Environmental Health Surveillance for air quality. | |
| Source: Ministry of Health (ZOVSA, 2019) Agreement 048 of 2014 SIATA – SMA (2020). | |
| SR4.2: Noise | |
| Indicator: Density of sites with higher noise levels | |
| 78.53Km2 of the city concentrates the highest noise levels given the two multiple land uses. | |

Source: Action Plan for Climate Change and Variability PAC&VC 2018 – 2030 (partial results as of November 2019)

Sustainable Urban Development



Figure 4.41: Synthesis Challenge 5: Sustainable Urban Development

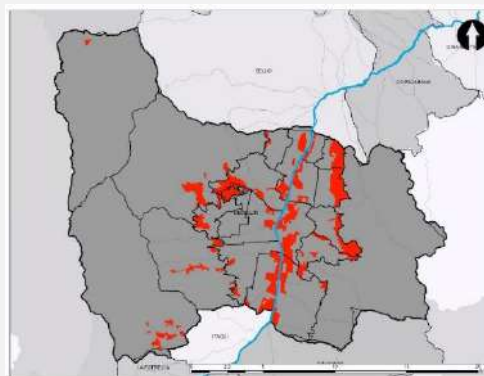
20% of urban land is between the treatments of urban renewal, urban development and integral improvement. Which implies that at least 10% of the land that is in renovation and urban development can be executed with intervention strategies based on nature. These areas are an opportunity to generate a balance between natural elements and urban development infrastructures. The 10% of the land that is within the treatment of integral improvement, are areas where the processes of public spaces and improvement of housing units can be benefited by re-naturalization processes.

R5: SUSTAINABLE URBAN DEVELOPMENT

SR 5.1: Urban Treatments

Indicator: Areas of renovation, development and integral improvement treatments

20% of the urban land is within the treatments of urban **renewal, urban development and integral improvements.**



Source: Agreement 048 of 2014

Participatory Planning and Governance



Figure 4.42: Synthesis Challenge 6, participatory planning and governance

Public spaces, as dictated by Colombian regulations, are spaces equipped for the recreation of citizens. In this sense, the management of green spaces must be implemented from two perspectives: as an adaptation to the conditions of climate change in the most critical areas due to problems in air quality and intervening in existing public spaces and generating new ones to qualitatively and quantitatively increase public space and its distribution in the city. This work must proceed hand in hand with activities and training on environmental issues involving communities in the processes of design and construction of spaces promoting the sense of belonging, appropriation of places and identity of the citizen.

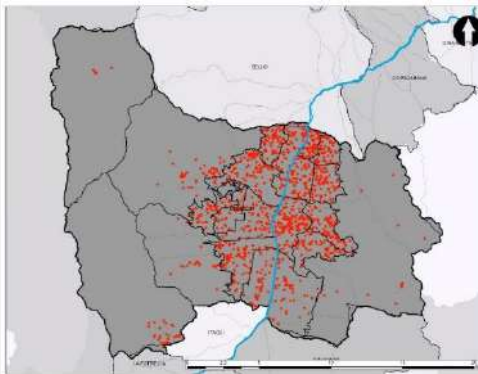
The World Health Organization (WHO) defines as an ideal value 15 m² of public space per inhabitant. This index is proposed as the dimension of free space that a person must have in urban areas in terms of health. Integrated green management from the promotion of green projects must be synchronized with this goal of the WHO, in order to generate spaces that, although not specifically for the meeting of citizens, help increase the relationship of built spaces and free spaces within the city in order to improve habitability and increase the scarce index of 3.68 m² of public space that Medellín currently has.

R6: PARTICIPATORY PLANNING AND GOVERNANCE

SR6.1: Environmental Prevention

Indicator: Density of training in environmental issues

1,930 points of activities and training on environmental **issues**



Source: Ministry of the Environment. 2019

SR6.2: Integrated Green Management

Indicator: Density of green projects

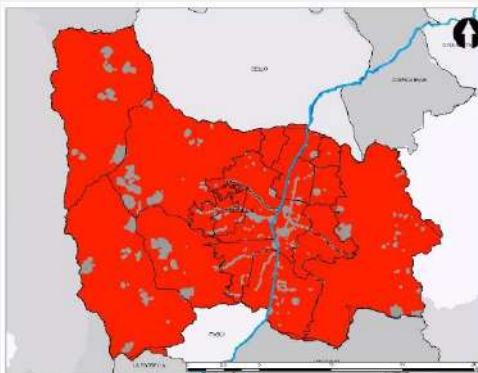
Early actions:

20 green walls

1.007 Eco-orchards

59.8 ha of runners intervened

20.2 ha of gardens



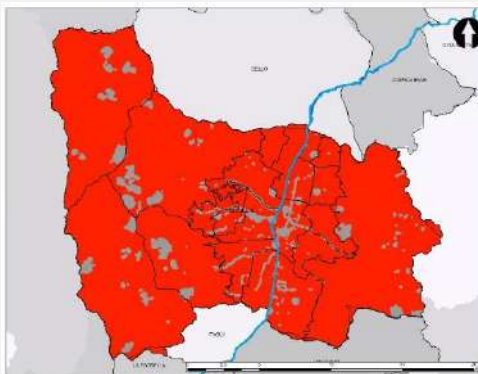
Source: Ministry of the Environment. 2019

SR6.3: Citizen Identity / Meeting Spaces

Indicator: Density of effective public spaces

1,020.7 ha of effective public space exists

3.68 m² per inhabitant



Source: Agreement 048 of 2014

Justice and Social Cohesion

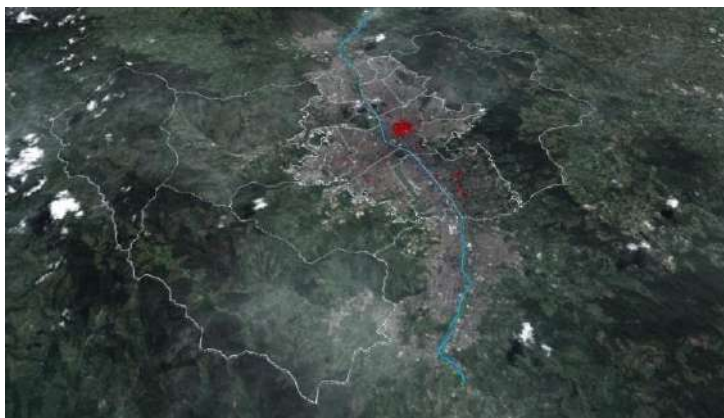


Figure 4.43: Justice and Social Cohesion

The areas where the largest built areas are concentrated (La Candelaria, Laureles Estadio, Belén and El Poblado) are the same areas where there is a greater concentration of legal entities and a greater number of crimes. In these areas can be implemented nature-based interventions from management processes between legal entities and institutional entities. In this sense, different actors can be involved in the processes, as well as improving security conditions by generating a higher quality of spaces and promoting the permanence of people in these areas.

| R7: JUSTICE AND SOCIAL COHESION | |
|---|--|
| <p>SR7.1: Capabilities</p> <p>Indicator: Density of environmental complaints</p> | |
| <p>SR7.2: Distribution</p> <p>Indicator: Density of m³ built</p> <p>The central and southern area of Medellín have the highest concentration of m³ built.</p> <p>The city has an average of 5,624 m³/ha</p> | |

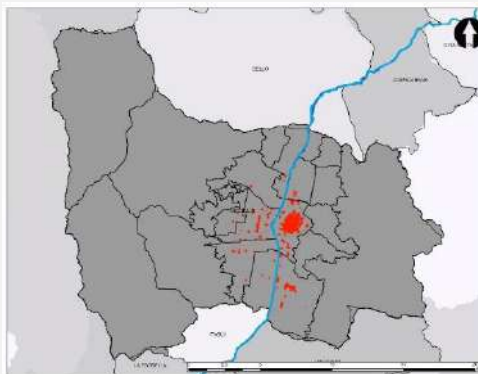
Source: PQRSD Environmental petitions, complaints, suggestions and complaints. AMVA 2019

Source: Cadastral base municipality of Medellín. 2018

SR7.3: Procedures / Genuine Inclusion

Indicator: Crime density

Of the **61,949 crimes** reported in 2018 **58%** is due to the theft of people

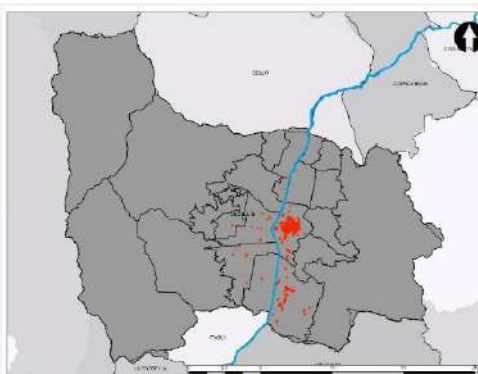


Source: Secretary of Security and Coexistence. 2018

SR7.4: Recognition of different social groups

Indicator: Density of actors

More than **40,000 legal entities** are identified as actors that obey commercial and service activities



Source: Secretary of the Environment, Agreement 048 of 2014, EPM Energy Meters.2018

Welfare and Public Health

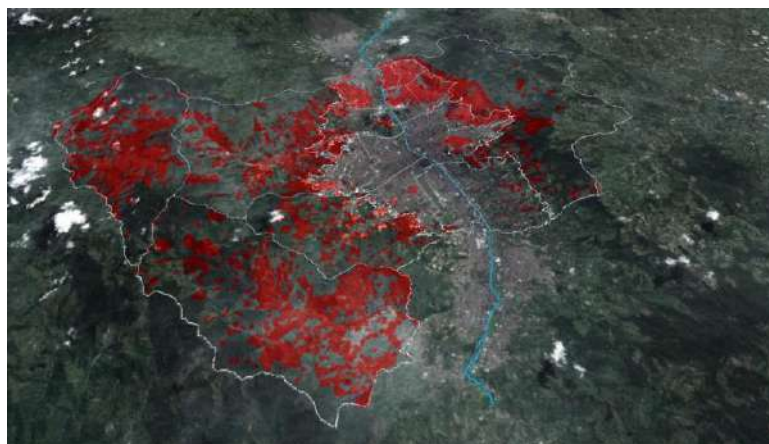
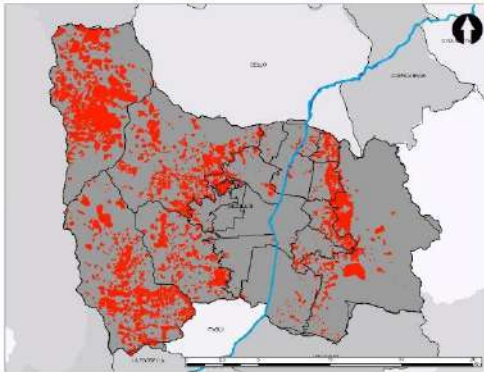
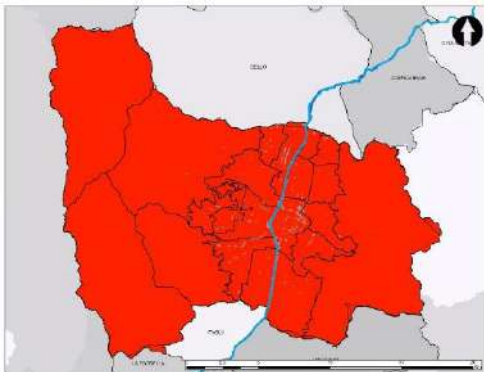
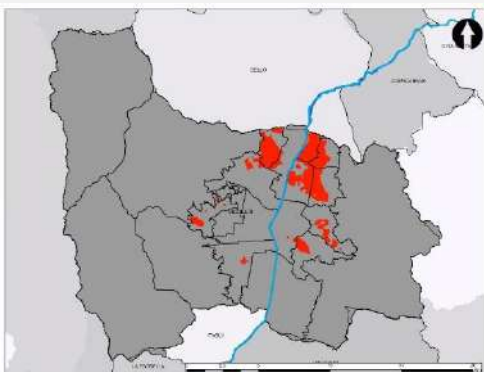


Figure 4.44: Synthesis Challenge 8, welfare and public health

The challenge of well-being and public health implies for Medellín, to identify and analyse the socio-environmental conditions and the effects derived from climate change in those places where the population with the highest number of diseases is located, sites coinciding with some of the areas prioritized by medium and high threat by mass movement and fires of vegetation covers, in which, in turn, the importance of stimulating the generation of spaces for the development of physical activities associated with the road network and cycle-routes is

identified as part of Nature-based Solutions, without implying that they are the only ones to be considered.

In the same way, the socio-environmental conditions that alter the health of citizens must be evaluated and not only in the places where they spend the night, but in all those where there is a condition that violates them and puts their lives at risk. All these areas must have mitigation and adaptation interventions to climate change, reducing risks and improving the quality of life.

| R8: WELFARE AND PUBLIC HEALTH | |
|--|--|
| SR8.1: Reducing risks in vulnerable communities |  |
| Indicator: Threat areas from mass movement and fires | |
| 9,153 hectares 24% of the municipal area is in a risk area due to mass movement or fires | |
| Source: Agreement 048 of 2014 - Risk Management Plan for Medellín 2015 | |
| SR8.2: Encourage physical activities |  |
| Indicator: Density of the pedestrian network and bicycle route network | |
| 470 km of bicycle route 1,381 km of pedestrian network | |
| Source: Agreement 048 of 2014 | |
| SR8.3: Mental Health and Well-being |  |
| Indicator: Density of diseases related to climate change | |
| The northeastern NE zone appears with the highest concentration of diseases, followed by the northwestern and central NW zone. | |
| Source: Ministry of Health. 2019 | |

4.7.3 Spatialization of Challenges and *Subretos* in Medellín

Spatialization of challenges

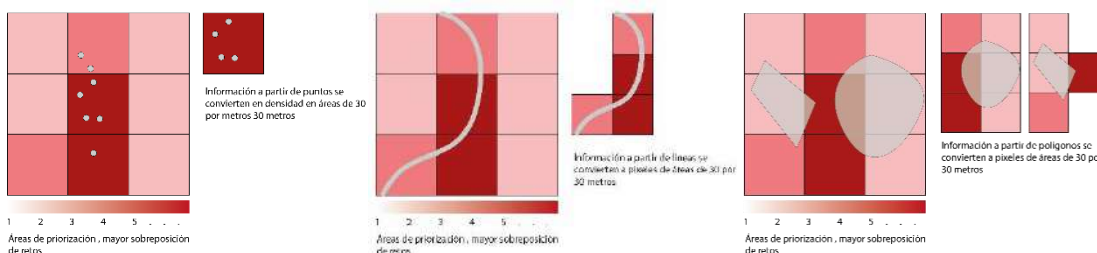


Figure 4.45: Spatialization of challenges diagram

For each of the *subretos*, information is identified that can be spatialized in order to identify by means of cartography the problems of the city. The spatial representation of this information is given by means of points, polygons or line, which becomes pixels of 30 by 30 for a spatial homologation. As for the attributes that evidence the levels of the problems and in turn of the *subretos* that this cartography contains expressed in lines, point and polygons are classified into 10 ranges, taking the last range as the most critical situation of the indicator, that is, as the areas to prioritize.

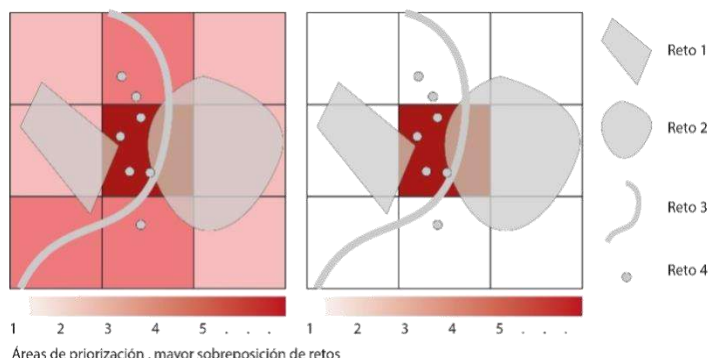


Figure 4.46: *Subretos* diagram

The prioritized areas for the challenges are classified between 0 and 1. Being 1 the most critical areas prioritized in the last range of the indicator calculated for each *subreto*. In this way the different *subretos* are added, identifying the areas with a greater number of superimposed *subretos*, understood as the most critical areas of the city, where re-naturalization strategies must be applied from NBS.

Behaviour of the *subretos* in the communes of Medellín

To identify the incidence of challenges and *subretos* in the communes and neighbourhoods of the municipality of Medellín, the information of the cells of 30x30 meters is taken with the presence or absence of the *subretos*. In this way the cells with the data of each of the *subretos* are grouped by communes, taking the value of the average of the cells within each polygon, identifying the status of each of the challenges and *subretos* in the administrative areas, and

understanding that the values closest to 15 (the largest number of *subretos* that accumulate in a cell) are the most critical areas of the city.

| Rank | Prom. Suma <i>Subreto</i> comunas | |
|-----------|-----------------------------------|------|
| 1. Low | 4,6 | 6,5 |
| 2. Medium | 6,5 | 8,7 |
| 3. High | 8,7 | 10,0 |

Table 4.13: Definition of ranges for the average sum of over position of *subretos* for comunas of Medellín

From the classification of low, middle and high ranges²⁸ according to the average of the sum of *subretos* that overlap, it is identified that five comunas (24%) are in a low range, seven (33%) in a middle range and nine (43%) in a high range as evidenced in Figure 4.47. Considering that the over position of *subretos* are evidence of the accumulation of city problems, those comunas that are in a high rank should be prioritized for re-naturalization in Medellín.

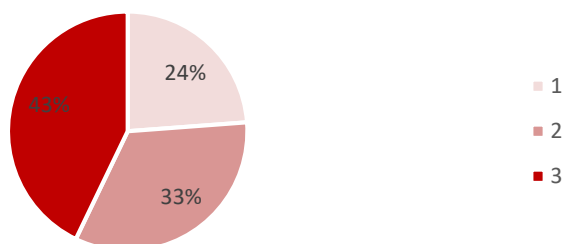


Figure 4.47: Percentage of comunas according to ranges of the average of the sum of overlapping *subretos*

Among the comunas that are identified in a high rank due to the over position of *subretos*, are in order of highest to lowest the Doce de Octubre, Popular, Aranjuez, San Javier, Manrique, La América, La Candelaria, Santa Cruz and Castilla. In the middle range are located the comunas Laureles Estadio, Villa Hermosa, Robledo, Buenos Aires, Guayabal, Belén and El Poblado. In a low range are located the corregimientos of San Cristóbal, Altavista, San Antonio de Prado, Santa Elena and San Sebastián de Palmitas as evidenced in Figure 4.48.

²⁸ Ranges defined by natural breaks

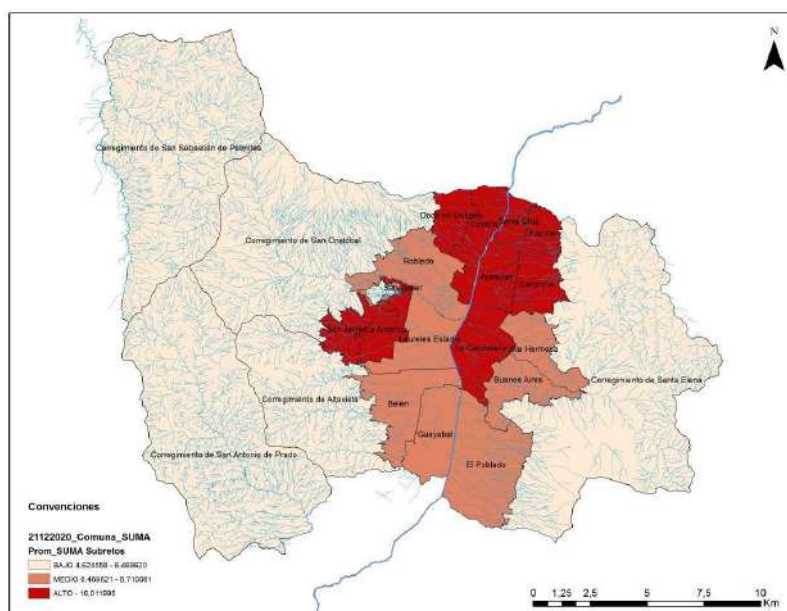


Figure 4.48: Average ranges of over position of *subretos* for the communes of Medellín

In relation to the classification of ranges and the spatial distribution of the same, all the corregimientos (peripheral areas) of the municipality are in a low range, which evidences a lower position of problems. This result demonstrates the absence of proper urban activities in these areas, which decreases the heat islands, the low density of green areas or the poor quality of water due to direct discharges to the bodies of water. The communes that are located in a high range tend to be in the centre, the north and especially some communes located on the rural urban edge of the city. These problems are due to the effects of heat islands, the change of permeable soils for impermeable soils, the lack of density of green areas and public spaces among other problems that are evidenced in the disaggregation of *subretos* in Table 4.14.

| COMMUNE | r1s1 | r1s2 | r2s1 | r2s2 | r2s3 | r2s4 | r3s1 | r3s2 | r4s1 | r4s2 | r5s1 | r6s1 | r6s2 | r6s3 | r7s1 | r7s2 | r7s3 | r7s4 | r8s1 | r8s2 | r8s3 | Prom. Subreto Sum |
|------------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|-------------------|
| Doce de Octubre | 0,86 | 0,77 | 0,09 | 0,00 | 0,99 | 0,99 | 0,83 | 0,87 | 1,00 | 0,00 | 0,07 | 0,37 | 0,99 | 0,97 | 0,18 | 0,00 | 0,00 | 0,00 | 0,07 | 0,96 | 0,90 | 10,0 |
| Popular | 0,18 | 0,68 | 0,13 | 0,00 | 0,99 | 0,99 | 0,73 | 0,99 | 1,00 | 0,00 | 0,48 | 0,35 | 0,97 | 0,99 | 0,22 | 0,00 | 0,00 | 0,00 | 0,51 | 0,98 | 0,39 | 9,7 |
| Aranjuez | 0,34 | 0,76 | 0,05 | 0,00 | 1,00 | 1,00 | 0,81 | 0,99 | 1,00 | 0,06 | 0,20 | 0,32 | 0,88 | 0,93 | 0,17 | 0,01 | 0,03 | 0,00 | 0,05 | 0,92 | 0,77 | 9,5 |
| San Javier | 0,37 | 0,54 | 0,10 | 0,99 | 0,00 | 0,00 | 0,81 | 0,96 | 0,97 | 0,03 | 0,24 | 0,22 | 0,86 | 0,97 | 0,17 | 0,07 | 0,00 | 0,00 | 0,19 | 0,98 | 0,72 | 9,5 |
| Manrique | 0,10 | 0,62 | 0,04 | 0,00 | 1,00 | 1,00 | 0,74 | 1,00 | 1,00 | 0,07 | 0,42 | 0,31 | 0,94 | 1,00 | 0,16 | 0,00 | 0,00 | 0,00 | 0,37 | 1,00 | 0,42 | 9,4 |
| La America | 0,45 | 0,63 | 0,04 | 0,97 | 0,00 | 0,00 | 0,92 | 0,94 | 0,41 | 0,56 | 0,01 | 0,20 | 0,79 | 0,98 | 0,09 | 0,19 | 0,02 | 0,01 | 0,01 | 0,97 | 0,98 | 9,4 |
| La Candelaria | 0,52 | 0,81 | 0,06 | 0,54 | 0,14 | 0,14 | 0,82 | 0,95 | 0,28 | 0,21 | 0,34 | 0,34 | 0,67 | 0,95 | 0,04 | 0,38 | 0,30 | 0,24 | 0,00 | 0,84 | 0,80 | 9,4 |
| Santa Cruz | 0,34 | 0,86 | 0,11 | 0,00 | 0,98 | 0,98 | 0,71 | 0,97 | 1,00 | 0,00 | 0,13 | 0,51 | 0,86 | 0,98 | 0,27 | 0,00 | 0,00 | 0,00 | 0,15 | 0,93 | 0,47 | 9,3 |
| Castile | 0,41 | 0,61 | 0,07 | 0,00 | 0,99 | 0,99 | 0,66 | 0,94 | 0,97 | 0,00 | 0,23 | 0,25 | 0,99 | 0,92 | 0,09 | 0,00 | 0,02 | 0,01 | 0,03 | 0,90 | 0,71 | 9,0 |
| Laureles Stadium | 0,34 | 0,66 | 0,02 | 0,64 | 0,00 | 0,00 | 0,82 | 0,98 | 0,23 | 0,32 | 0,07 | 0,22 | 0,81 | 0,98 | 0,04 | 0,38 | 0,09 | 0,03 | 0,00 | 0,94 | 0,94 | 8,7 |
| Beautiful Villa | 0,14 | 0,52 | 0,09 | 0,00 | 0,08 | 0,08 | 0,68 | 0,98 | 1,00 | 0,06 | 0,34 | 0,28 | 0,95 | 0,93 | 0,18 | 0,03 | 0,00 | 0,00 | 0,39 | 0,99 | 0,68 | 8,5 |
| Oak wood | 0,21 | 0,38 | 0,05 | 0,47 | 0,53 | 0,53 | 0,50 | 0,97 | 1,00 | 0,01 | 0,18 | 0,22 | 0,90 | 0,84 | 0,13 | 0,00 | 0,01 | 0,00 | 0,19 | 0,97 | 0,57 | 8,4 |
| Buenos Aires | 0,21 | 0,46 | 0,03 | 0,27 | 0,00 | 0,00 | 0,67 | 0,96 | 0,45 | 0,22 | 0,20 | 0,22 | 0,96 | 0,95 | 0,14 | 0,10 | 0,00 | 0,00 | 0,15 | 0,99 | 0,87 | 8,1 |
| Guayabal | 0,60 | 0,61 | 0,02 | 0,46 | 0,00 | 0,00 | 0,70 | 0,96 | 0,13 | 0,09 | 0,33 | 0,13 | 0,90 | 0,98 | 0,03 | 0,06 | 0,01 | 0,00 | 0,01 | 0,96 | 0,77 | 8,0 |
| Bethlehem | 0,28 | 0,54 | 0,04 | 0,08 | 0,00 | 0,00 | 0,72 | 0,95 | 0,63 | 0,39 | 0,06 | 0,21 | 0,87 | 0,96 | 0,10 | 0,18 | 0,02 | 0,01 | 0,03 | 0,96 | 0,64 | 7,9 |
| The Village | 0,05 | 0,26 | 0,07 | 0,88 | 0,00 | 0,00 | 0,73 | 0,96 | 0,00 | 0,00 | 0,13 | 0,08 | 0,89 | 0,99 | 0,12 | 0,21 | 0,04 | 0,05 | 0,04 | 0,95 | 0,59 | 7,4 |



| | | | | | | | | | | | | | | | | | | | | | | |
|------------------------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|-----|
| Corr. San Cristobal | 0,02 | 0,03 | 0,00 | 0,93 | 0,06 | 0,06 | 0,60 | 0,99 | 0,26 | 0,00 | 0,04 | 0,02 | 0,91 | 0,99 | 0,01 | 0,00 | 0,00 | 0,00 | 0,27 | 1,00 | 0,28 | 6,5 |
| Corr. Altavista | 0,00 | 0,04 | 0,02 | 0,25 | 0,00 | 0,00 | 0,29 | 1,00 | 0,16 | 0,00 | 0,04 | 0,02 | 0,90 | 1,00 | 0,01 | 0,00 | 0,00 | 0,00 | 0,26 | 1,00 | 0,13 | 5,1 |
| Corr. San Antonio Prado | 0,01 | 0,02 | 0,01 | 0,00 | 0,00 | 0,00 | 0,39 | 0,99 | 0,00 | 0,00 | 0,02 | 0,01 | 0,94 | 0,99 | 0,01 | 0,00 | 0,00 | 0,00 | 0,31 | 0,99 | 0,13 | 4,8 |
| Corr. Saint Helena | 0,01 | 0,01 | 0,00 | 0,17 | 0,07 | 0,07 | 0,41 | 0,99 | 0,09 | 0,00 | 0,00 | 0,00 | 0,95 | 0,98 | 0,00 | 0,00 | 0,00 | 0,00 | 0,11 | 0,99 | 0,09 | 4,8 |
| Corr. San Sebastian Palmitas | 0,01 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,31 | 0,99 | 0,00 | 0,00 | 0,00 | 0,00 | 0,93 | 0,99 | 0,00 | 0,00 | 0,00 | 0,00 | 0,39 | 0,99 | 0,00 | 4,6 |
| Overall total | 0,09 | 0,16 | 0,02 | 0,29 | 0,11 | 0,11 | 0,49 | 0,98 | 0,23 | 0,03 | 0,07 | 0,07 | 0,92 | 0,98 | 0,04 | 0,03 | 0,01 | 0,01 | 0,22 | 0,98 | 0,28 | |

Table 4.14: Presence of each *subretos* in communes being 0 the lowest value and 1 the highest

The classification of ranges according to the accumulation of problems allows to identify the communes as priorities for the re-naturalization of Medellín. In addition, it is necessary to clarify that the detail mentioned above to identify specific areas can indicate some urban areas of the corregimientos and specific areas of some communes, since the interpretation of the data in the administrative polygon accounts for the total area, and the corregimientos are largely rural. In this sense, the classification by communes is a first approximation that can help prioritize areas of intervention from the municipal administration, which must be reviewed in detail in the scales already mentioned in the previous paragraph.



Characterisation of the *subretos* in the neighbourhoods of Medellín

| Rank | Prom. <i>Subreto</i> Sum | |
|-----------|--------------------------|------|
| 1. Low | 4,0 | 6,7 |
| 2. Medium | 6,7 | 8,9 |
| 3. High | 8,9 | 11,7 |

Table 4.15: Definition of ranges for the average sum of over position of *subretos* for neighbourhoods of Medellín

The process carried out with the communes is repeated with the neighbourhoods to have more limited areas for the selection of areas to prioritize in order to implement the re-naturalization of the city. For the data of these polygons, ranges are defined, where the grouping of *subretos* begins to be greater taking into account that the areas to be averaged are smaller and the selection of cells of 30x30 has smaller variations, having a maximum average of the accumulation of 11.7 *subretos* of how it is evidenced in the classification of ranges in Table 4.15. Within these ranges, 66 neighbourhood polygons (20%) are located in a low range, 109 (33%) in a medium range and 154 (47%) in a high range as can be seen in Figure 4.49.

Distribución de barrios según rangos de promedio de suma de subretos

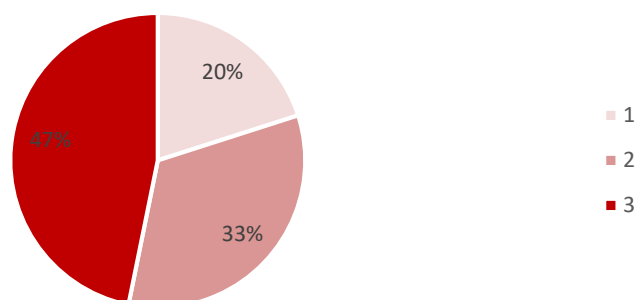


Figure 4.49: Percentage of neighbourhoods according to ranges of the average sum of overlapping *subretos*, with rank ranging from 1 (low) to 3 (high).

The presence of challenges by neighbourhoods allows to identify with greater precision the most critical areas of the city as shown in Figure 4.50 where the presence of more critical neighbourhoods in the centre of the city, the northeast area and the edge of the slope of the western side is evident. This spatial representation allows the prioritization of specific sectors of the communes, even unlike the representation of the average of the sum of challenges by communes it is possible to differentiate the urban areas of corregimientos such as San Antonio de Prado or San Cristóbal, where their urban headwaters stand out with a medium range unlike the rest of the corregimental polygon which maintains a low range.

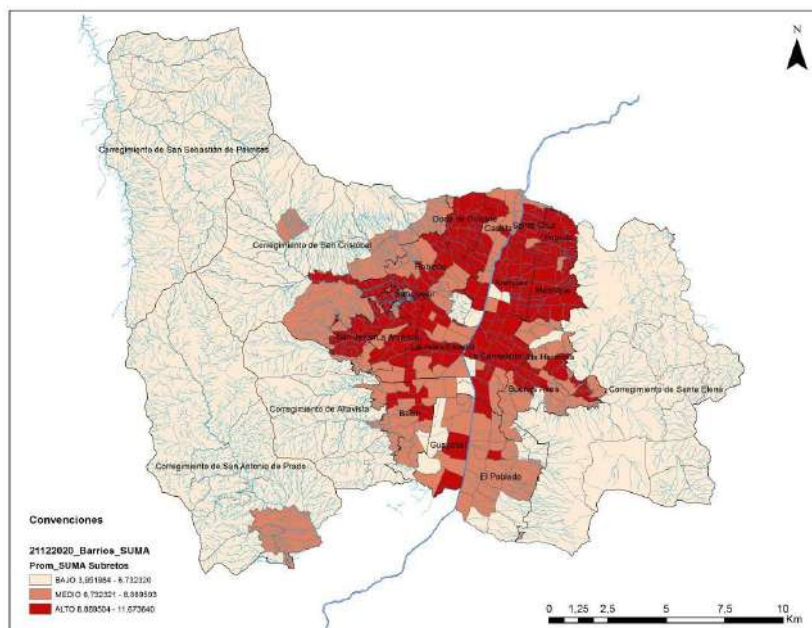


Figure 4.50: Average ranges of over position of *subretos* for the neighbourhoods of Medellín.

In the information provided by communes, El Doce de Octubre ranks as the commune with the highest value in relation to the over position of challenges, however, the Manrique, San Javier and El Popular communes register from 89% to 86% of their neighbourhoods in a high range of over position of challenges, even Manrique and San Javier do not register neighbourhoods in low ranges as represented in Table 4.15. In this sense, this information is key to formulating and articulating strategies for the re-naturalization of Medellín, since the administrative unit by which interventions are prioritized must be clear to use the available tools for decision-making. Annex 4 and 5 contain the details of the over position of each of the neighbourhoods and the range where it is according to the distribution of the data, within this ranking the ten neighbourhoods with the highest criticality are: Las Independencias, Blanquizal, Mirador del Doce, Moravia, La Candelaria, Guayaquil, La América, Bomboná No.1, Manrique Central No.1 and Manrique Central No.2.

4.7.4 Structure for the classification of the territorial offer

The territorial offer understood as the physical landscape in which the implementation of NBS is intervened to face the problems of the city represented by the challenges and the *subretos*, are structured from three strategies, in order to articulate the methodological positions of the RUP and territorial structure of the mayor's office of Medellín. In this way, the green, blue and gray infrastructures proposed are related; the systems and subsystems of the Medellín Territorial Planning Plan (agreement 48 of 2014); and the categories of the Medellín Forestry Manual to achieve a multiscale application of the Re naturalization Plan (see Figure 4.51)

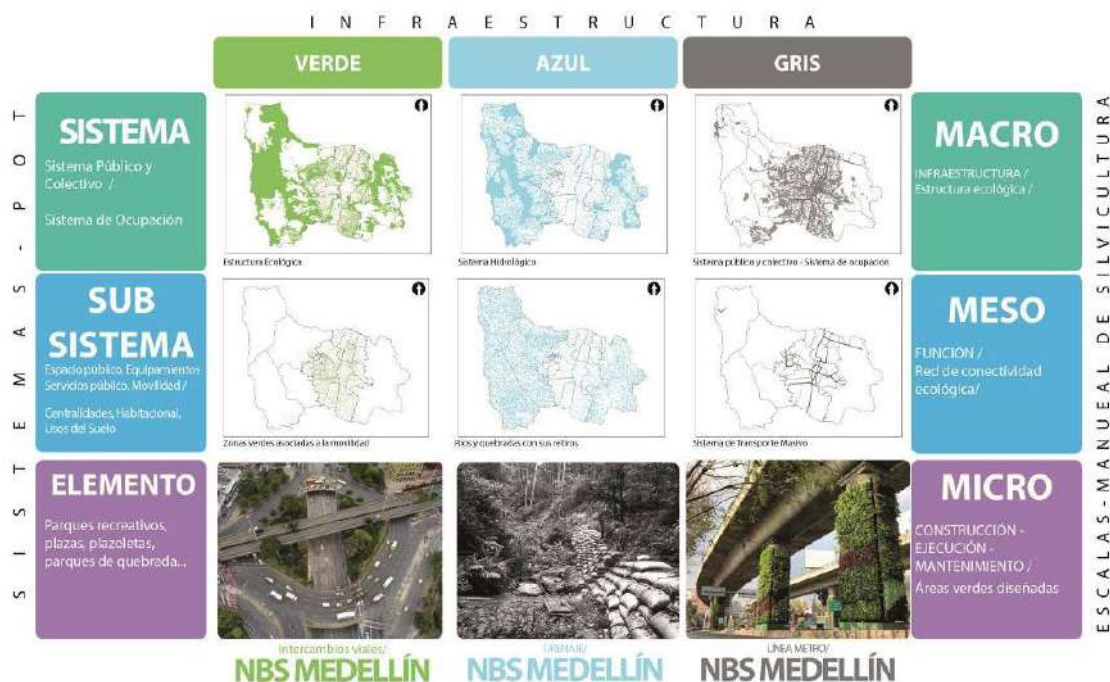


Figure 4.51: Conceptual scheme to structure the territorial offer of the Medellín Re naturalization Plan. NBS must be implanted across the range of green, blue and grey infrastructure. This classification allows to easily identify the types of NBS that are applied on each of the elements according to their nature.

In order to maintain a multiscale strategy, the 3 scales proposed by the Medellín Forestry Manual are incorporated. A Macro scale that focuses on defining a main and complementary ecological structure from a city infrastructure, a meso scale that focuses on specifying the ecological connectivity network with functional green areas and a micro scale that is responsible for developing and designing those specific elements that are within the green areas that generate the ecological connectivity network.

Articulating these three strategies, the proposed structure for the territorial offer of the RUP seeks to clearly identify the green, blue and grey infrastructures in which the different categories of NBS can be incorporated according to their characteristics. Identifying within the structure of the POT of Medellín the way to intervene the green, blue and grey infrastructure in coherence with agreement 048 of 2014 from the system and subsystem proposed in it, in order to have the technical feasibility for the application of NBS in the Municipal System of Territorial Planning. These three strategies become tools that make it possible to implement a Re naturalization Plan in the context of Medellín.

As presented in Figure 4.51, the classification of green, blue and grey infrastructure is carried out in relation to the TEP in order to relate to its structure and that the identified elements can be articulated with the planning and intervention strategies of agreement 48 of 2014. In addition to relating to the scales of the Forestry Manual taking into account the functions of green spaces in a context of city system. This classification must be carried out in a systemic

way, where the macro, meso or micro-scales proposed by the Forestry Manual and the systems, subsystems and elements of the POT are nested, that is, that some are incorporated in others so that the multi-scalar reading is real, where it is evidenced that the interventions carried out in a micro element or scale can have effects on the meso or macro scale and on the subsystems and systems as seen in Table 4.16.

This relationship with the TEP allows to identify some interventions, projects or planning instruments with the infrastructures as evidenced in the cell of Planning Instruments of Table 4.16. This means that according to the impacts that are desired to be generated or the possibilities of intervention, the infrastructure must be identified and those responsible for its management in the different depended on the administrative structure of the municipality to intervene on said element, subsystems or systems, having specific and responsible physical space according to the expected effects.

| INFRASTRUCTURE | POT | SYSTEMS | SUBSYSTEMS | ELEMENTS |
|---------------------|-----------------------|---|---|--|
| | Planning tools | POT/Macro-projects / Integral Urban Projects of the Hillside Area / Rural Peasant Districts | Partial Plans / Urban Legalization and Regularization Plans / Master Plans / Rural Planning Units / Special Plans for the Management and Protection of Heritage | Projects - Actions - Interventions |
| | FORESTRY MANUAL | MACRO | MESO | MICRO |
| | Actions and functions | INFRASTRUCTURE / Ecological structure | FUNCTION / Ecological connectivity network | CONSTRUCTION - EXECUTION - MAINTENANCE / Green areas designed on a small scale |
| | Green Infrastructure | Systems 1 | Subsystem 1 | Element 1 |
| | Green Infrastructure | Systems 1 | Subsystem1 | Element 2 |
| | Green Infrastructure | Systems 1 | Subsystem2 | Element 1 |
| | Green Infrastructure | Systems 1 | Subsystem2 | Element 2 |
| | Blue Infrastructure | Systems 1 | Subsystem 1 | Element 1 |
| | Blue Infrastructure | Systems 1 | Subsystem1 | Element 2 |
| | Blue Infrastructure | Systems 1 | Subsystem2 | Element 1 |
| | Blue Infrastructure | Systems 1 | Subsystem2 | Element 2 |
| | Grey Infrastructure | Systems 1 | Subsystem1 | Element 1 |
| Grey Infrastructure | Systems 1 | Subsystem1 | Element 2 | |
| Grey Infrastructure | Systems 1 | Subsystem2 | Element 1 | |
| Grey Infrastructure | Systems 1 | Subsystem2 | Element 2 | |

Table 4.16: Hierarchal structure for the classification of green, blue and grey infrastructure.



In the following section it is shown the breakdown of each system of infrastructure into its subsystems and locations.

Green infrastructure and its subsystems

| Infrastructure | Macro – System | | Meso - Subsystem | Micro – Element |
|---|--|--|--|---|
| GREEN 78% of the municipal estate 29299.55 ha | Protected Areas | 28% of the municipal estate 10598.56 ha | Agreement48 | Protected areas |
| | | | | Eco- Borde Park |
| | | | | Eco- Cerro Park |
| | | | RUNAP Medellín | Peri-urban Green Zone |
| | | | | Other Green Areas |
| | Orographic | 16% of the municipal polygon 5841.30 ha | Green areas of the orographic system | Orographic System |
| | Ecological Network | 26% of the municipal estate 9816.57 ha | Rural Ecological Network | Rural Ecological Network |
| | | | Green areas of the Hydrographic System | Eco- Parque Quebrada |
| | | | | Quebradas Artificial Retreat |
| | | | | Quebradas Natural Retreat |
| | | | Green areas of Public Space | Green areas Mirador |
| | | | | Green areas Parque Cívico |
| | | | | Green areas Parque Recreativo |
| | | | | Green areas Plaza |
| | Complementary Ecological Network | 8% of the municipal estate 3043.11 ha | Rural Complementary Ecological Network | Rural Complementary Ecological Network |
| | | | Green areas of public buildings | Green areas of Institutional Buildings |
| Green areas Activity Node | | | | |
| Green areas Mobility System | | | Green areas Fajas Taludes | |
| | | | Green areas Franja Amoblamiento | |
| | | | Green areas Glorieta | |
| | | | Green areas Oreja Puente | |
| Green areas Parking | | | | |
| Green areas Separator | | | | |



| | | | | |
|--|-------------------|--|-------------------|-----------------------------|
| | | | | Green areas Antejardín |
| | | | | Green areas Areas to Cede |
| | | | | Green areas Industry |
| | | | Urban green areas | Green Areas Residential |
| | | | | Residual Green Areas |
| | | | | Green areas Retiro Linderos |
| | | | | Green areas Annexed |
| | Tree System Urban | 40,974 trees Registered in SAU | Urban Tree System | Urban Tree System |

Table 4.17: Green Infrastructure Classification

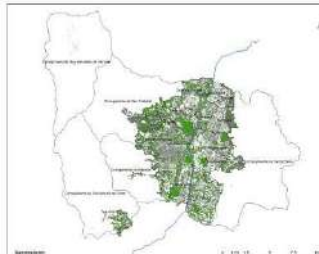
Macro Green Infrastructure



Meso Green Infrastructure



Micro Green Infrastructure



Green Infrastructure Macro – Meso – Micro

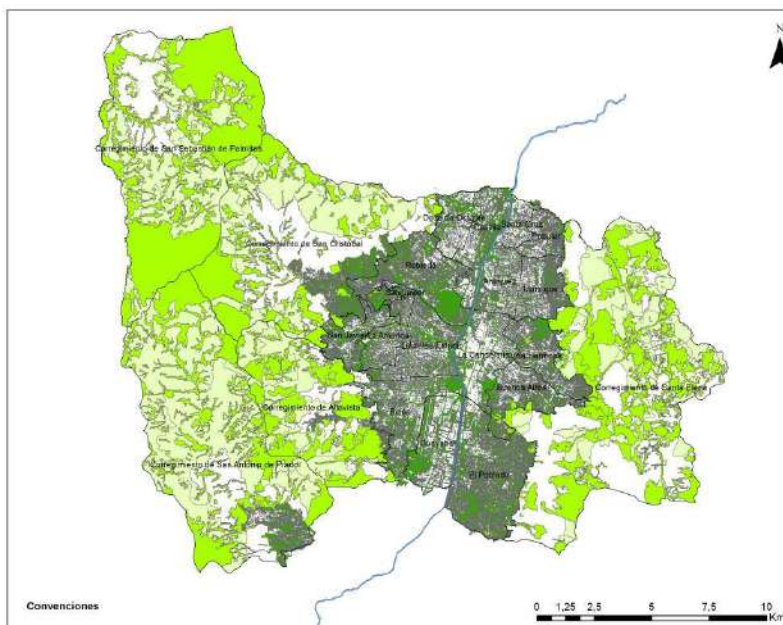


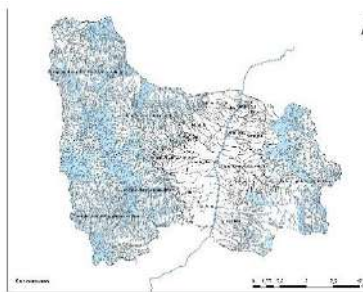
Table 4.18: Cartography related to the classification of Green infrastructure

Blue infrastructure

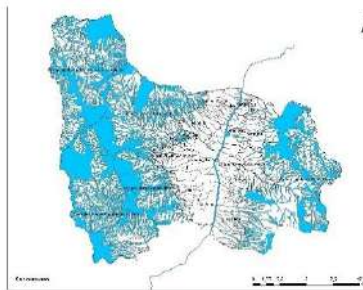
| Infrastructure | Macro – System | | Meso - Subsystem | Micro – Element |
|----------------|---------------------|---|--|------------------------------------|
| BLUE | Hydrographic System | 55% of the municipal area is an area for the protection of water resources 20,866 ha | Basins | |
| | | | Wetlands and their Retreats | Wetlands |
| | | | | Wetland Retreats |
| | | | Rivers and Streams with their Retreats | Rivers and Streams Natural channel |
| | | | | Rivers and Streams Covered channel |
| | | | | Rivers and Streams Mixed channel |

Table 4.19: Blue Infrastructure Classification

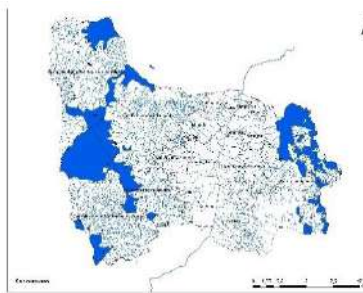
Macro Blue Infrastructure



Meso Blue Infrastructure



Micro Blue Infrastructure



Blue Infrastructure Macro – Meso – Micro

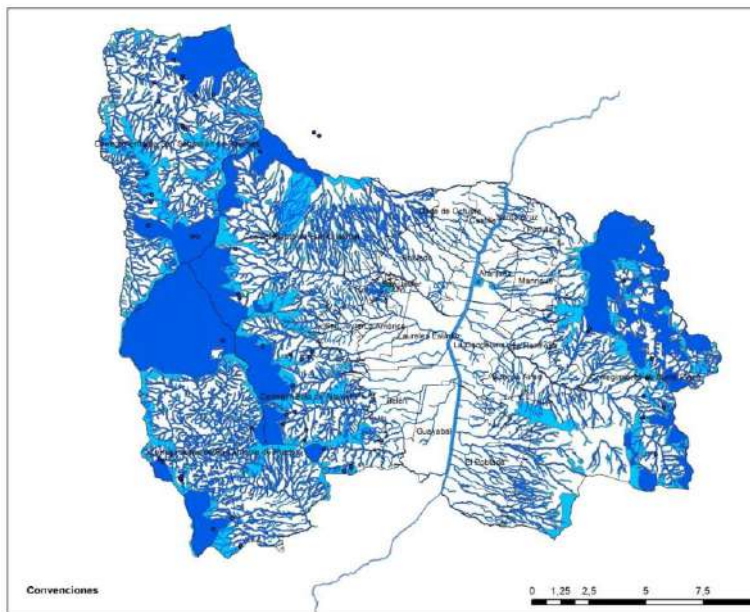


Table 4.20: Cartography related to the classification of blue infrastructure

Grey Infrastructure

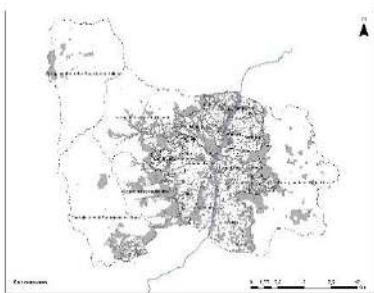
| Infrastructure | Macro – System | | Meso - Subsystem | Micro – Element | |
|--------------------|---------------------|---|-------------------------------|--------------------------|--|
| GREY | Public Space System | 14% of the municipal polygon destined to existing and projected public space 5,166 ha | Public Space tente | Balcony | |
| | | | | Civic Park | |
| | | | | Recreational Park | |
| | | | | Square | |
| | | | | Square | |
| | | | | Square | |
| | | | Projected Public Space | Eco park | |
| | | | | Balcony | |
| | | | | Civic Park | |
| | | | | Recreational Park | |
| | Equipment System | 5% of the municipal estate destined or to equipment 2,016 ha | Construction equipment | of | Horizontal built-in surfaces |
| | | | | Equipment grounds | Vertical built-in surfaces |
| | Mobility System | 3,044 km From the Mobility System 1451 km Road hierarchy km 474 km of existing and planned cycle trails 760 km from the pedestrian system | Passenger Transport Corridors | of | Whereabouts |
| | | | | | Passenger Transport Corridor – Collective public transport |
| | | | | | Metro Line |
| | | | | | Metrocable Line |
| | | | | | Tram Line |
| | | | | | Metroplus Line |
| | | | Mass Transit System | Stations | |
| | | | Pedestrian Network | Grey infrastructure | |
| Pedestrian network | | | | | |
| Cycle routes | | | Cycle parks | | |
| | Encycle Stations | | | | |
| | Cicloruta Causeway | | | | |
| Road Hierarchy | Rural | | | | |
| | Urban | | | | |
| Occupancy system | 5% of the municipal | Centres | of | Centrality Constructions | |
| | | | | Properties Centralities | |



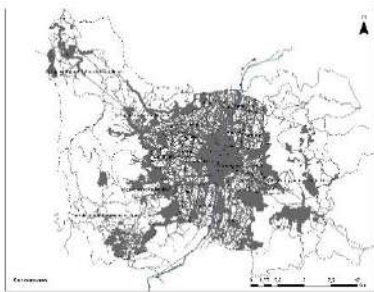
| | | | | |
|--|-----------------------|---|----------|--|
| | | <p>Area of centralities 1923 has 5% Area of constructions in economic centralities and mixed corridors 2884 ha</p> | Runners | <p>Constructions Corridors s Mixed</p> <p>Properties Corridors s Mixed</p> <p>Mixed Rural Urban</p> <p>Rural corridors</p> |
| | Public Service System | <p>11 One Purification plants 264 Water tanks</p> | Aqueduct | Water Treatment Plant |
| | | | Aqueduct | Water Tank |

Table 4.21: Classification of grey infrastructure

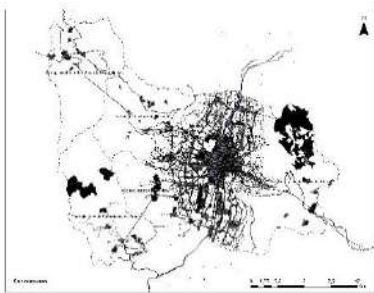
Grey Macro Infrastructure



Meso Grey Infrastructure



Micro Grey Infrastructure



Grey Infrastructure Macro – Meso – Micro

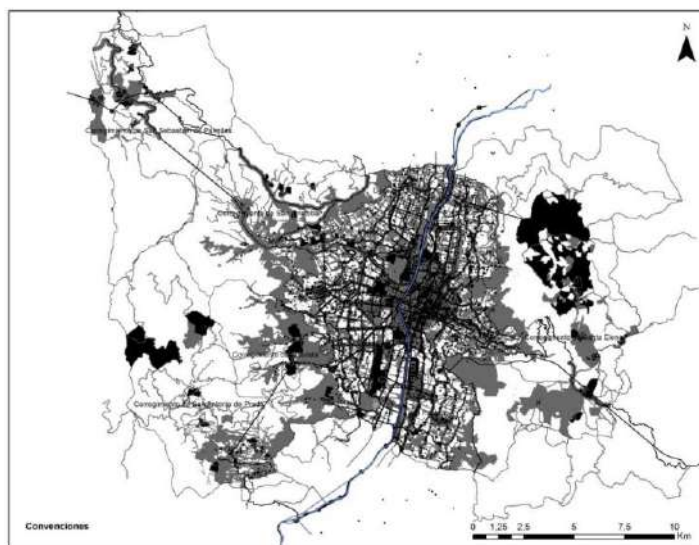
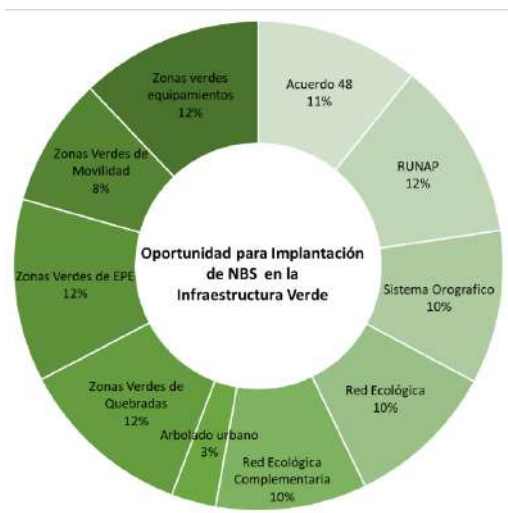


Table 4.22: Cartography related to the classification of grey infrastructure

4.7.5 Intersection of challenges and territorial offers

After having identified the different aspects related to each of the elements that constitute the territorial model and that in turn answer the questions registered in the document of the Strategy for the Re-naturalization of Medellín:

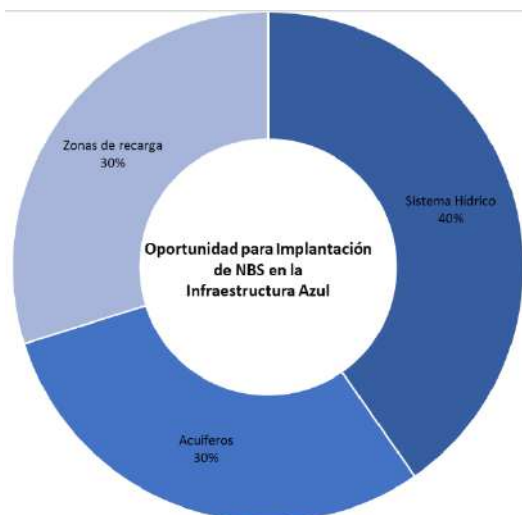
- Where to prioritize interventions with NBS?
- In which infrastructures to operate?
- And which NBS to use?



GREEN INFRASTRUCTURE

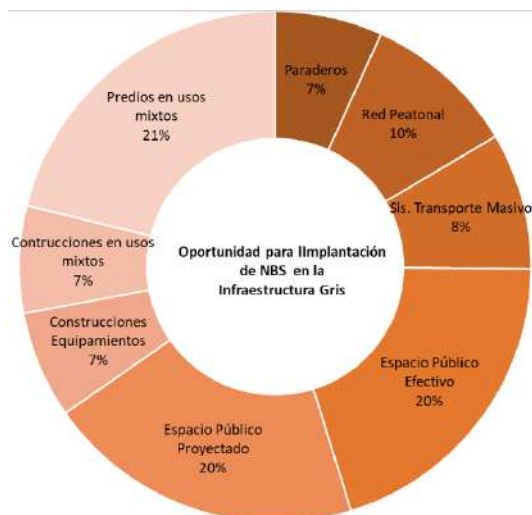
When analysing the different elements that constitute the green infrastructure of the city, opportunities are identified for the implementation of very homogeneous NBS, with an overall average of 10% with respect to the total for this infrastructure, ranging between 8 and 12% mainly.

However, the green areas associated with mobility, equipment, existing public space, streams and protected areas registered in the RUNAP are those that present the highest levels of opportunity.



BLUE INFRASTRUCTURE

On the other hand, the opportunities of the elements that constitute the blue infrastructure identified from the spatial elements of Agreement 048 of 2014 present more or less the same opportunities to implement NBS.



GREY INFRASTRUCTURE

Mixed-use properties, projected public spaces and effective public space correspond to the elements of the green infrastructure with greater opportunities for the implementation of NBS with respect to the other elements that constitute the grey infrastructure.

With this analysis of the territorial offer and the spatial demand of NBS, there is the basis for spatial planning of NBS delivery. In the following chapter, past applications of spatial data for the identification of urban re-naturalisation priorities are demonstrated.

Quality spatial information, integrated with the Financial Model and the Management Model articulated in subsequent chapters, forms the basis for the delivery of the RUP. Chapter 12 shows how all these elements are integrated in a working model for NBS delivery.

4.8 Spatial planning case study: Ecological Connectivity

Below will be shown the early NBS that are currently being developed by the mayor's office of Medellín before the implementation of the Re-naturalization Plan. This arises from what is structured in Decree 895 of 2018 "By means of which the Urban Forestry Manual for Medellín - Management, Planning and Management of Green Infrastructure is adopted and other provisions are dictated" framed in the phase of planning and multiscale design of green and its intervention at different scales: macro, meso and micro, where the first implementations of Nature-based Solutions are seen.

In this chapter several cases of studies that have been carried out from 2017 to the present will be shown. One of them is part of the "Inter-administrative contract for the development of the pilot project for the ecological connectivity of the urban green corridors of the city of Medellín" this has a focus from the planning of the landscape through delimitation of landscape units, which are defined by districts and the definition of 6 typologies of green corridors that provides guidelines to more efficiently address the public space and the way in which ecological connectivity should be applied for the attraction of avifauna. As a result of this work, two exercises are derived. One is the project of "30 green corridors" that is already implemented in the city and was winner of the ASHDEN award and the analysis of district 1 focused on the look of Re-naturalization through what is being consolidated in the formulation of the re-naturalization plan, both exercises are on a macro-meso-scale.

It also shows how addressing in the micro scale the application of NBS, through what is developed in component 4 corresponding to the territorial prioritization model that are part of the structure of the Re-naturalization Plan alluding to how to work the 9 challenges of the city and the possible spatialization of the NBS in both urban and rural areas. This exercise has been called "Early Interventions in Urban Green" and is the staging of several of the typologies already implemented in Medellín and that are part of the catalogue delivered by the URBAN GreenUP project. These NBS are mostly developed by the Secretary of the Environment, also the Secretary of Physical Infrastructure, the Secretary of Economic Development, the Secretary of Women, the Secretaries of Supplies and Services and the Landscape Agency; these become practical cases of successful actions, giving validity to everything framed and what is structured in the Renaturalization Plan.

4.8.1 Pilot Project for the Ecological Connectivity of the Urban Green Corridors of the City of Medellín

From the point of view of urban management and planning, the landscape is the result of the way in which the different components of the environment, both natural (geomorphology, the water network, plant covers, soils, flora and fauna) and cultural (urban morphologies, current land use and its treatments and other adaptations and human interventions on the territory) interact and are perceived by the population. Everything that the population perceives about the environment also becomes the concept of urban landscape, not only from the visual part but also from the way in which it can be heard and smelled, the feelings, memories and associations that the inhabitants evoke.



The first step for the implementation of conservation actions through the design of biological corridors and connectivity routes in heterogeneous environments is the analysis of the landscape and the different elements that compose it (Vogt *et al.* 2009). According to the type of data and the characteristics of the landscape elements quantified, three different approaches can be grouped: **i)** The spatial and geometric structure of habitats in the landscape such as shape, size and distance between habitat fragments; **ii)** Surfaces (raster), in which environmental gradients and environmental quality are represented through the use of surfaces of any environmental variable related to the resistance or permeability to the movement of organisms (for example, topography, percentage of vegetation cover, etc.); and **iii)** Graph theory or network analysis, in which the functional response of species to the different elements of the landscape is modelled. Once the contribution of the different elements of the landscape to connectivity is quantified, actions for the conservation of biodiversity include the design of green infrastructure or actions on areas that have a significant contribution to the mobility of organisms, so that the environmental conditions of areas that present high resistance are improved.

Ecological connectivity is a tool for the conservation of natural resources, their functions and services, for these measures must be taken to facilitate the dispersion of organisms through natural, semi-natural and artificial areas through ecological corridors (green corridors) or fragments with actions that increase the permeability of the landscape. The overall objective, in terms of biodiversity conservation, when managing or improving landscape connectivity is to mitigate the negative effects of fragmentation, coverage change and habitat degradation that interventions such as urbanization produce. In this sense, the biggest challenge is to propose ecologically functional and lasting connectivity networks, which are also visible by the urban population, while being incorporated as a new alternative for the enjoyment of urban public space and sustainable interaction between population, flora and fauna in the city.

Considering all the above, the Ministry of the Environment developed Phase I through the project "Pilot Project for the Ecological Connectivity of the Urban Green Corridors of the Municipality of Medellín", which was developed for 25% of the urban area of the city. This study was framed in the Development Plan "*Medellín Cuenta con Vos 2016 – 2019*", within the strategic dimension – A city commitment to the care of the environment, in the program "Green Infrastructure: Generation, Conservation and Maintenance of green spaces" seeking the Consolidation of ecological networks for the protection of fauna and flora.

One of the objectives of the project is to consolidate an ecological connectivity network that allows generating new city scenarios, through the recovery and planned planting, the greening and modelling of the landscape within the framework of the human-ecosystem relationship. This project (Phase I) was developed with the inter-administrative contract 4600067020, 2016 between the National University of Colombia (UNAL) and the Ministry of the Environment, which contemplated the following:

1. **Orthophotography:** The area of aerial orthophotography comprised an area of 10,780 hectares (urban area of Medellín and corregimental Centralities). Spatial resolution of 7 cm. to produce the orthophoto at 1:500 scale.

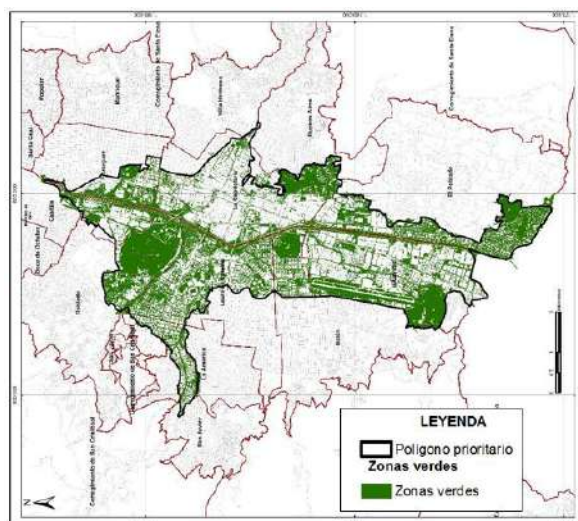


2. **Definition of a priority polygon for the development of the pilot project and inventory of green areas:** the study area covered the central area of the City in the alluvial plain, which represents 25% of the urban area of the Municipality of Medellín, on this area the inventory of public and private green areas was carried out, with a level of detail greater than 4 m² (see Figure 4.53). Each zone incorporated the attributes that categorize them as components of the main or complementary ecological structure in their different components of the systems of the structuring ecological network, the orographic system or the hydrographic system.

The priority polygon covered 2,955 ha, within which 827.6 ha of green areas corresponding to 48,351 polygons were found, representing 28% of the study area (see Figure 4.52).



Figure 4.52: Definition of priority polygon and inventory of green areas



- ✓ **Área Polígono piloto:** 2.955ha
- ✓ **Área zonas verdes:** 827,6 ha
- ✓ **Total ZV área verde efectiva:** Polígonos 48.351 (28%)

Figure 4.53: Existing green areas within the priority polygon

3. **Integral design of the pilot project:** it is composed of the design of functional ecological connectivity, the corresponding classification of the elements of the network and their level of importance, the analysis of the landscape and characterization of the green districts (homogeneous units of landscape) for greater management in the interventions and the general structure of a landscape plan, where the design of functional ecological connectivity is reflected.

Functional eco-friendly connectivity design

The ecological analysis and modelling of connectivity networks through Medellín's urban landscape involved the following steps:

- ✓ 9 species, guilds or communities were identified that represented the different requirements of the fauna populations of Medellín and for which information will be provided. Selecting 6 species of birds (*Ara severus* - Macaw cariseca, *Amazona ochrocephala* - Lora cabeciamarilla, *Eupsittula pertinax* - Perico cari sucio, *Catharus aurantirostris* - Orange-billed blackbird, *Momotus aequatorialis* - Barranquero and *Tangara cyanicollis* - Tángarareal) and three mammals (*Molossus molossus*-Mastiff bat, *Sciurus granatensis* - Redsquirrel, *Artibeus lituratus* - Fruitbat), see Figure 4.54 and Figure 4.55. These species will present a multi-specific approach, in mobility ability, landscape, food among others.

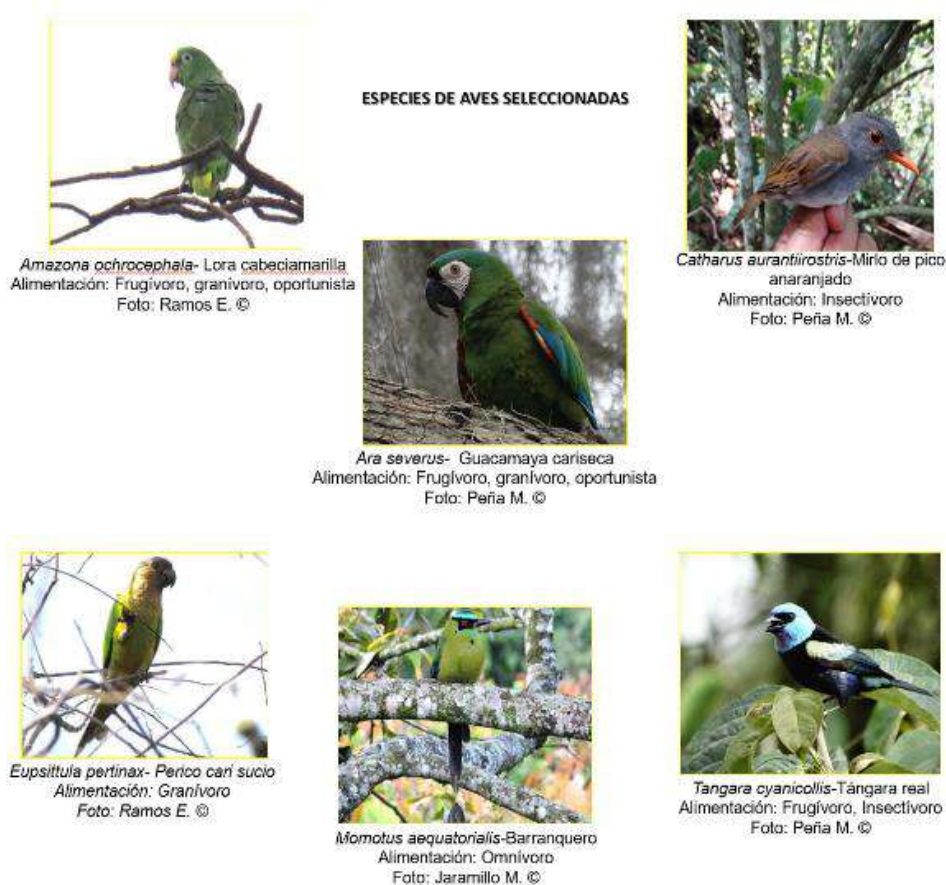


Figure 4.54: Selected bird species

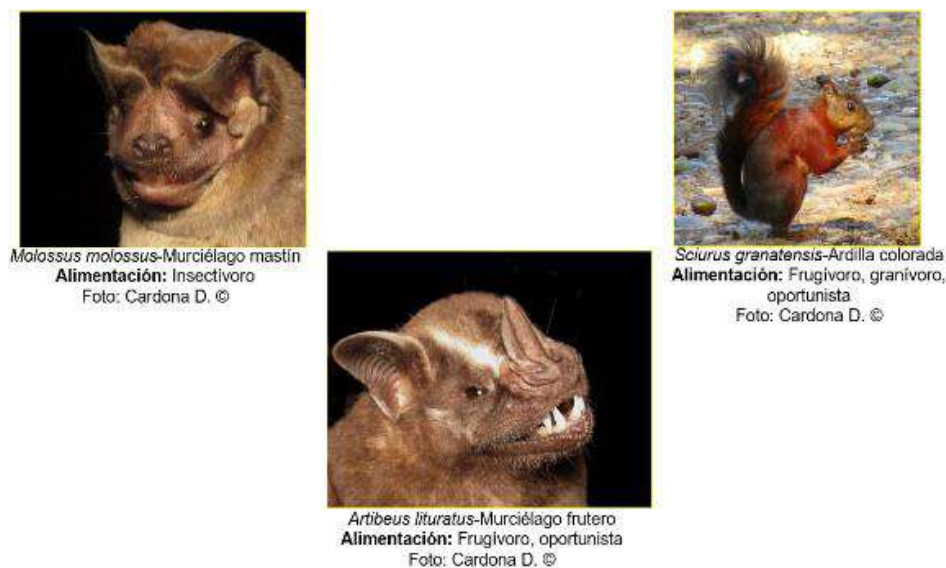


Figure 4.55: Species of mammals selected

- ✓ Construction of a matrix or surface of resistance (or impedance) to movement, according to different characteristics of the landscape and focal species. The resistance matrix is the representation of the permeability or resistance that the landscape offers to the flows of matter and energy, movement of individuals or gene flow between populations. For the analyses performed in this study, each resistance matrix is represented as a raster-type surface or map. To determine these matrices in an objective, robust and ecologically relevant way, the habitat suitability for each focal species was analysed. The suitability of habitat was obtained from ecological niche modelling, using the maximum entropy algorithm, using the free software Maxent 3.3.3k, for this the predictor variables that describe the landscape and can determine the distribution of the species were used. This study used variables derived from satellite images from the OLI (Operational Land Imager) and TIRS (Thermal Infrared Sensor) sensors of the Landsat-8 Earth observation satellite and an elevation model (DEM). Figure 4.56 shows graphically the procedure performed to obtain the resistance matrices and Figure 4.57 shows one of the matrices estimated for one of the nine species *Tangara cyanicollis*-Tángara real. In total, 18 models of matrices were estimated, one by the method of electrical circuits and another by the route method of lower travel cost.

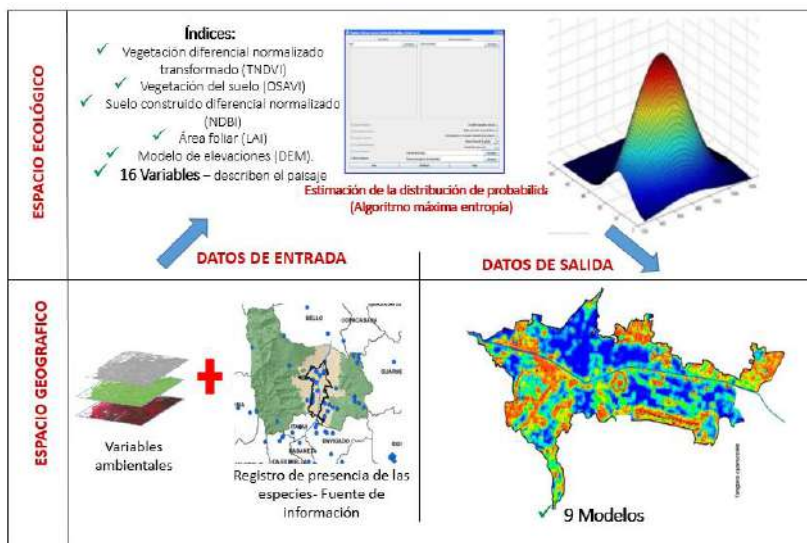


Figure 4.56: Procedure performed to obtain the resistance matrices

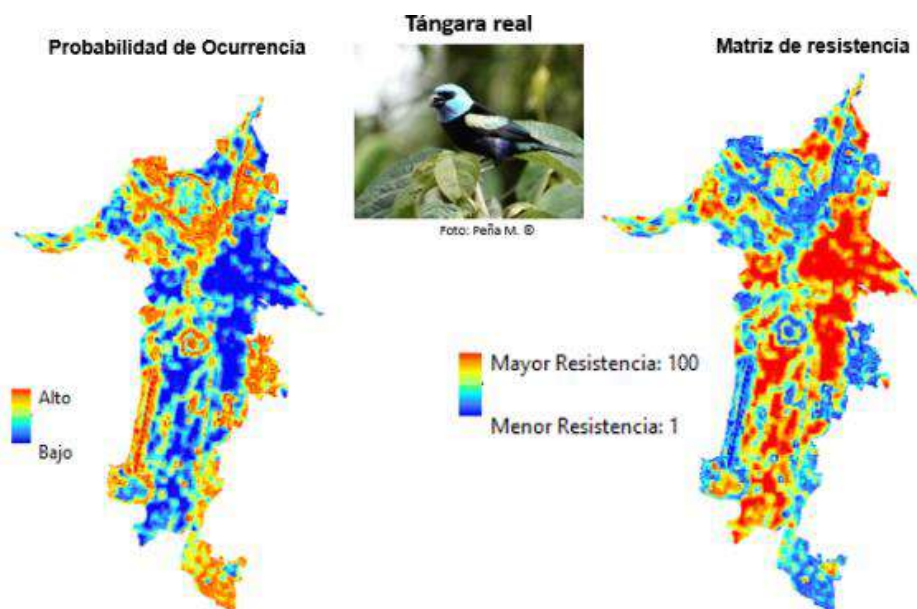


Figure 4.57: Probability of occurrence matrix and resistance matrix for the Real *Tanager cyanicollis*, one of the species analysed

- ✓ Identification of habitat nodes or nuclei. These areas theoretically represent areas where species find greater refuge and conditions to survive, acting as a source of individuals that move to other areas of the landscape. These areas are also important in terms of land management, as they constitute precisely the areas of greatest importance for conservation and whose priority to connect with other elements of the landscape is greater. For this study, two types were used, the nodes established in the POT (Territorial Planning Plan) and perimeter points that allow estimating connectivity routes throughout the study area (see Figure 4.58).

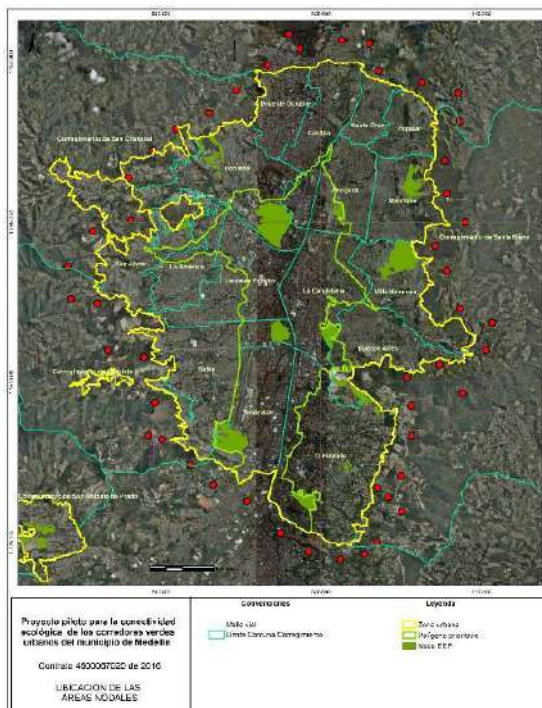


Figure 4.58: Nodes and perimeter points to estimate connectivity paths

- ✓ Modelling of the theoretical movement routes of organisms through the landscape between the nodes. The analysis of the connectivity networks was carried out with two complementary methodologies: the lowest travel cost route algorithm and the random walker and electrical circuit theory algorithm. The two methodologies make it possible to identify different elements of the functional ecological connectivity model of the study area. Figure 4.59 shows the connectivity model for each method. Subsequently, the final model of ecological connectivity was carried out (Figure 4.60), which allowed to assess according to the level of importance each green area (Figure 4.61) and according to what was found to establish the categories of management and prioritize interventions.

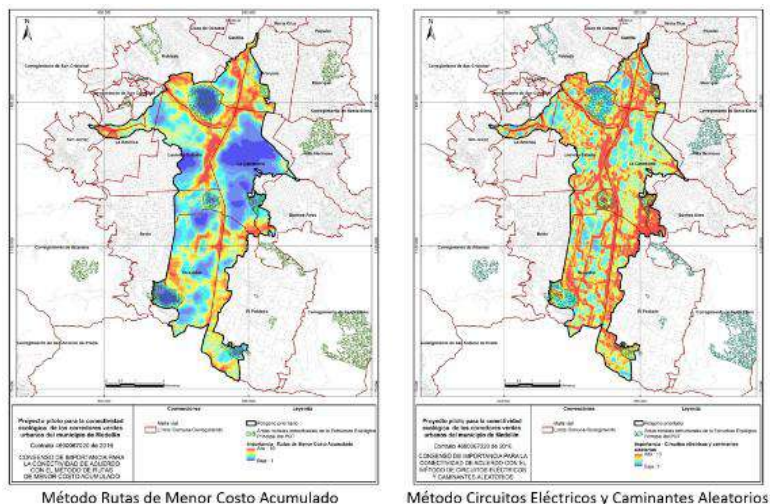


Figure 4.59: Connectivity model for each metho

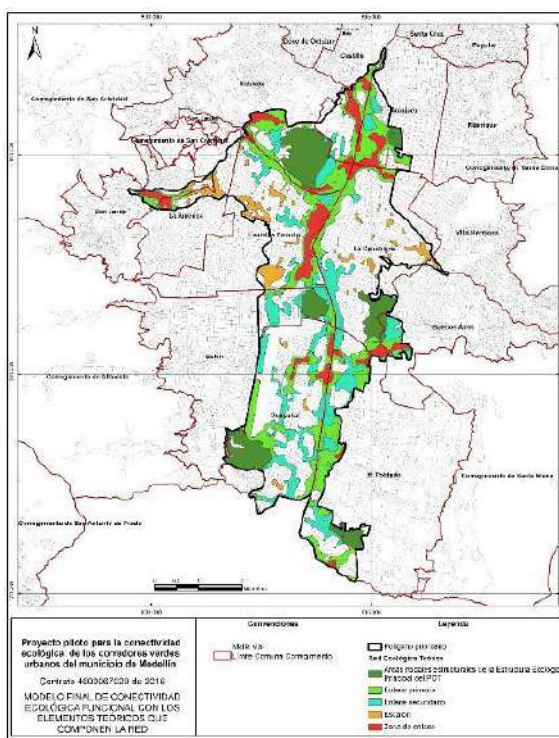


Figure 4.60: Final model of functional ecological connectivity with the theoretical elements that make up the network within the polygon

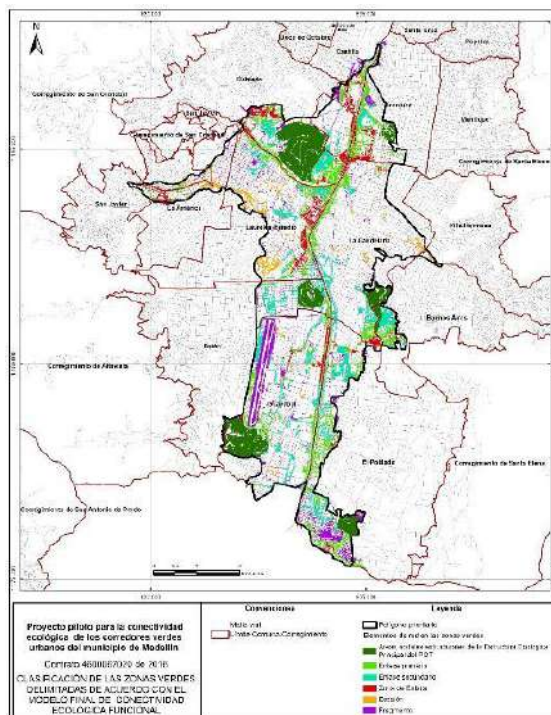


Figure 4.61: Classification of the delimited green areas according to the FINAL model of functional ecological connectivity

Based on the analyses carried out, it was possible to define a map specifying the areas that must be managed for the management of the ecological connectivity network in the priority polygon (Figure 4.62). For this, two groups of network management categories were defined: i. Conservation and enrichment, and ii. Restoration and re-creation. The areas destined for Conservation and enrichment correspond to the current network of connectivity and its network elements (Links, Link Zones, nodes, etc.); while the zones for Restoration and re-creation correspond, for the most part, to the areas around the step-like elements and the buffering areas of links and nodes. Additionally, in the areas for Restoration and re-creation, 11,561 green areas are identified, which are currently fragments, which could serve as a starting point for the restoration of functional connectivity in weak areas or where connections have been completely lost or degraded.

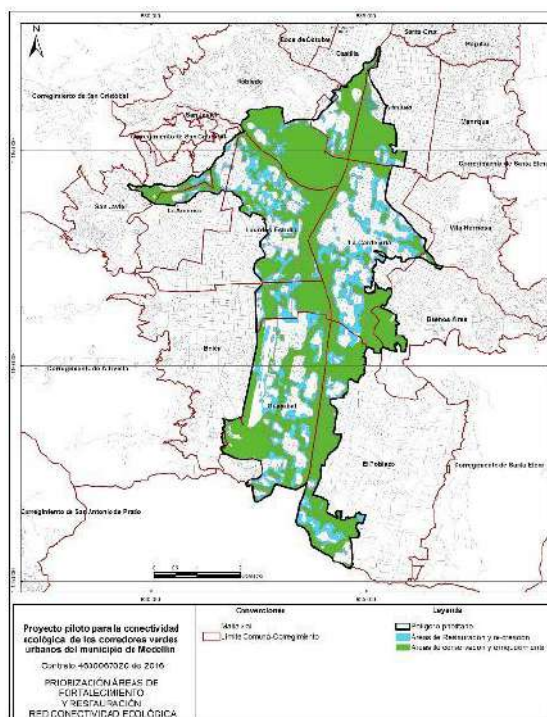


Figure 4.62: Priority areas for the management of the functional ecological connectivity network

Both the green areas belonging to network elements of the ecological model of functional connectivity (areas for Conservation and enrichment) and the areas for restoration and recreation, should be the first to be considered for the implementation of strategies for greening the city. One of the most used strategies for greening is the planting of trees and shrubs, which by themselves can help regulate the microclimate, water flows, increase the supply of ecosystem services and, in general, help reduce pollutants within the city. If the selection of planting sites takes into account the areas for Conservation and enrichment together with the areas for the restoration of connectivity (restoring and recreation) defined in this study, in addition to the benefits mentioned, they will allow to improve significantly, and even restore functional ecological connectivity in some areas of the city.

Taking into account the above, we proceeded to focus on the evaluation of the landscape and public space within the framework of the analysis of Functional Ecological Connectivity, to carry out the construction of the homogeneous landscape units, analysing the natural environment, built environment and human dimension (social and cultural), which allowed to identify or group the landscape units in districts or functional areas (Figure 4.63 and Figure 4.64).

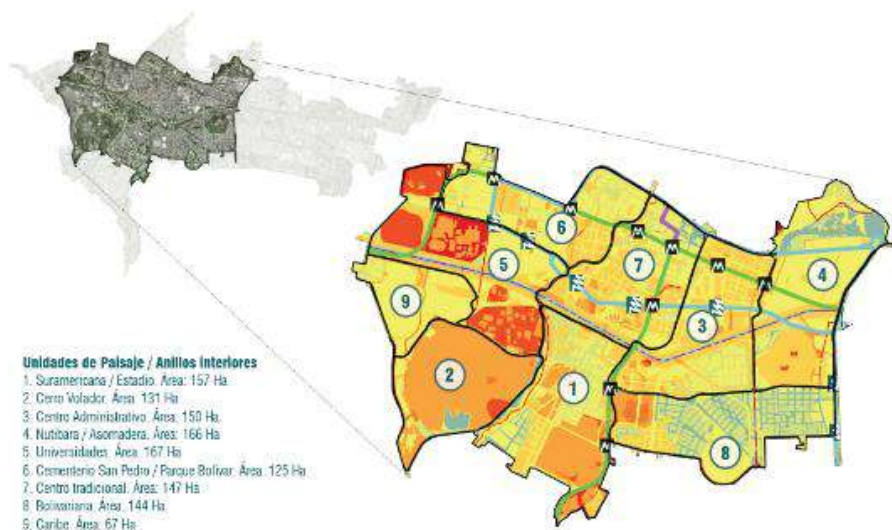


Figure 4.63: Grouping of Landscape Units in Functional Landscape Areas



Figure 4.64: Naming and defining landscape areas, such as Landscape Districts

The definition of landscape units or districts allows a better and greater management of the green infrastructure of the city, in which the actions required to improve the conditions present in the green areas are identified and potential actions to intervene with the different projects are identified. Strategies should be understood as a starting point for the design of public space; made from which the proposals of landscape design can be developed in detail at the level of arborization and gardens. The objective of this is to strengthen ecological connectivity along the ravines, defining an urban ecotone or mitigation area between urban uses and water resources and improving landscape quality based on ecological connectivity, for intervention related to green areas within the polygons associated with large city macro projects, to the road system, among others (see Figure 4.65).

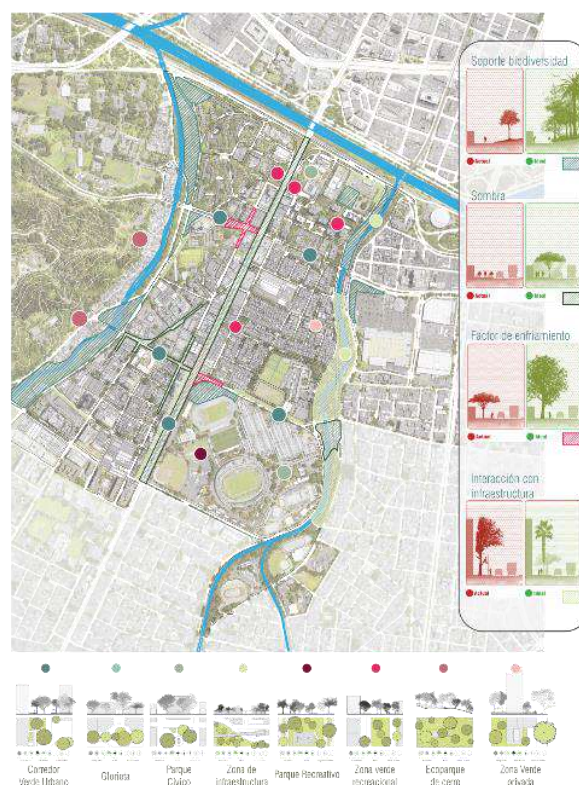


Figure 4.65: Intervention Areas and Landscape Strategies for the Design District

Therefore, the management of green areas, natural resources and their ecosystem services must be a key point in the development and territorial management based entirely on the ecology of the landscape and the social, cultural, political and economic perceptions of public and private space.

Specifically, for Medellín, the results obtained in this study allowed to define strategies for the design and implementation of the "Green Corridors" project within the "A Green Medellín for You" program of the Mayor's Office. These strategies are aimed at strengthening the functionality of the links and nodes of the ecological structure, improving their connectivity by generating new canopy in those green areas with patches of fragmented tree vegetation; as well as increasing the diversity of flora species, with the inclusion of multi-layer plantings, which improve the urban forest, providing more resources for fauna, while strengthening and diversifying the ecological niches present in the city.

This study has also provided the following benefits for the city:

- ✓ Classify the green component and identify possible new areas of planting green covers to promote connectivity between nodes and / or existing corridors in the established area, and that complement the green infrastructure of the City.
- ✓ Generate new green areas by eliminating hard floor.
- ✓ Management tool against the identification and prioritization of actions for the generation of new green areas, and implementation of suitable plant species(native).
- ✓ Element of decision against the intervention in public spaces (articulation of undersecretaries and vision of the city).

4.9 Management model: roles and responsibilities for delivery

Preliminary results of the process of building an institutional management model for the Medellín RUP are presented, as part of the commitments established in the URBAN GreenUP project.

Objective

The purpose is to consolidate a proposal for an organizational structure for the implementation of the Medellín 2030 Re-naturalization Plan. For this, it is necessary to consolidate the mapping of actors and instances of green management in the city, based on which to propose a scheme or model of organization and institutional operation for the implementation of the Plan.

Method

To achieve the objectives, 5 fields of analysis were considered (Figure 4.66) and three major processes were carried out.



Figure 4.66: Fields of Analysis for the Construction of a Management Model for the Medellín Re-naturalization Plan

Figure 4.66 shows the steps. The major processes were as follows:

1. Complete the identification of actors and instances related to the management of the green infrastructure and ecological structure of Medellín.
This was based on the regulatory analysis carried out in 2019 and was complemented by the review of the current and official administrative structure of the city (Decreets 883 of 2015 and 0863 of 2020).
2. Advance in the characterization of actors and instances related to green management in Medellín
 - 2.1. To this end, the functions of each of the identified actors were reviewed, identifying their role and general relevance for the management of the green infrastructure and the ecological structure of the city within the framework of a Re-naturalization Plan.

2.2. Additionally, a survey was designed and applied, sent to date to officials and contractors of about 50 institutions and entities, identifying the group of technical roles for green management in which they are involved, their perception of the capacities and resources for the fulfilment of these roles and functions, the actors with which they relate and the factors that contribute or hinder the articulation, the instances in which they participate, and the actions or strategies suggested to overcome the existing limitations or barriers to the fulfilment of their functions and competencies in relation to the management of the green infrastructure and the ecological structure of the city (https://docs.google.com/forms/d/1_AtPlgakQlKBfyH-jrLYnuJ6Lh-mSuQ2M7RgAORtcms/prefill).

The questions raised were as follows:

- *What functions and competences does your dependency have in relation to the management of the green infrastructure and the ecological structure of the city?*
- *How would you rate the current level of capacities of your unit to exercise those functions and competences? (five variables are qualified: quantity of human resources; suitability of human resources; availability of financial resources; quantity and quality of technological resources; interest and political will)*
- *What actions or strategies do you suggest to overcome existing limitations for the fulfilment of your functions and competences?*
- *Which internal or external actors do you relate to in order to fulfil your functions in relation to the management of the green infrastructure and the ecological structure of the city?*
- *What factors do you consider to facilitate or hinder the relationship with these actors?*
- *Mention the instances (committees, commissions, working groups, etc.) that exist for the fulfilment of their functions related to the green infrastructure and the ecological structure of the city*

2.3. In order to know the functions and actions that are assumed from different relevant instances, as well as to explore the possibility of intra-institutional articulation and joint action in the face of the Renaturalization Plan, 15 interviews were also conducted with the leaders of the relevant management instances identified.

4.9.1 Management Model for the Implementation of the Medellín Re-naturalization Plan

Based on the results obtained previously, a proposal for a Management Model is made for the implementation of the Medellín Re-naturalization Plan, which includes:

- Actors involved.
- Proposed roles and functions.
- Required instances.



Actors and instances related to the management of the green infrastructure and the ecological structure of Medellín.

Based on the regulatory analysis carried out in 2019, 59 actors with competences, functions, and roles associated directly or indirectly in the management of the green infrastructure and ecological structure of Medellín were identified. This management involves elements related to seven major processes:

- Conception and planning
- Formulation and design
- Generation and implementation
- Improvement and qualification
- Follow-up, monitoring, and evaluation
- Control and authority
- Research, education and awareness-raising.

After reviewing the current administrative structure of Medellín, actors were identified that may have a powerful or subsidiary importance for the Re-naturalization Plan, and that had not been previously identified because no norm related to the management of urban or rural green explicitly assigns them competences in this regard.

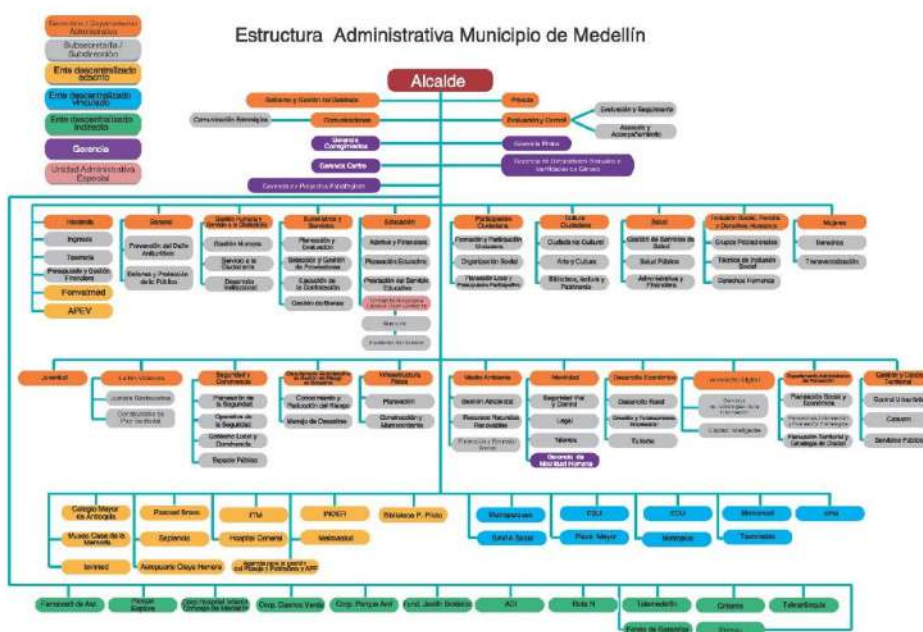


Figure 4.67: Administrative Structure Municipality of Medellín

All the identified actors are described in Annex 6, which analyses how their objectives and functions of law that could be more closely connected to the purposes of the Medellín Re-naturalization Plan.

As a consequence of the findings made, and in view of the strategic role for the planning, execution, monitoring and monitoring of the green infrastructure and the ecological structure of Medellín, the management model proposes the creation of a subsection of green



infrastructure and ecological structure, which concentrates human and financial resources today dispersed in different secretariats and decentralized entities, thus guaranteeing the uniqueness of criteria and action necessary for the materialization of the ecological structure of the city.

A greener and healthier Medellín needs the articulated work and joint financing of all the Secretariats, and from an Undersecretariat of Green Infrastructure and Ecological Structure that concentrates resources and functions of planning, intervention, monitoring, and evaluation, a Re-naturalization Plan for Medellín could be fully executed, as part of the city's Climate Action Plan.

The proposed structure can be seen in Figure 4.68.

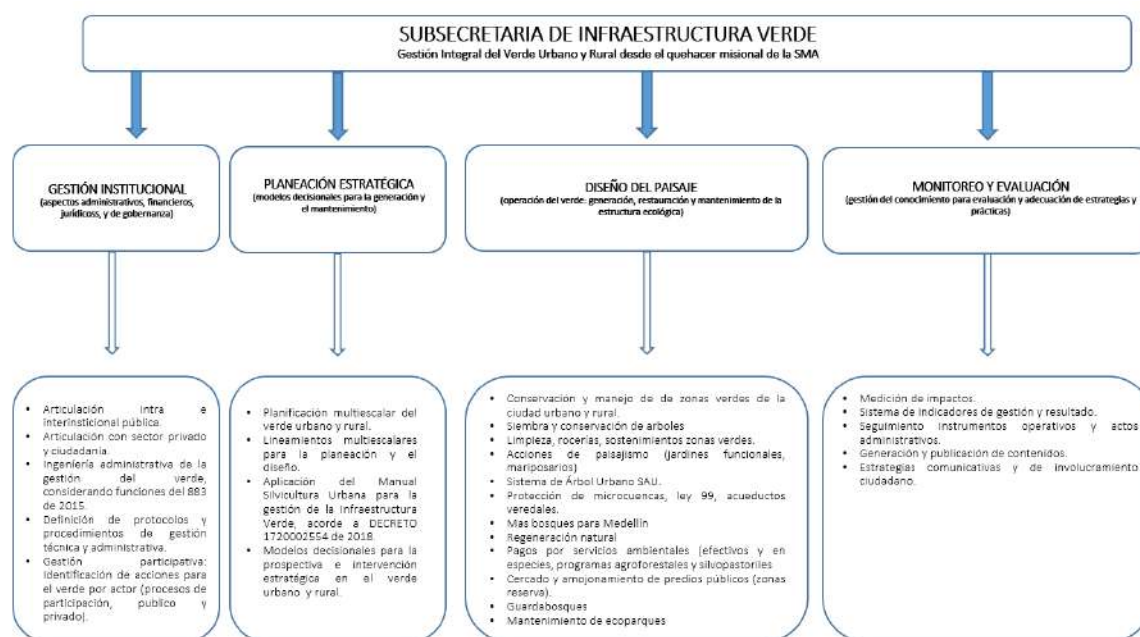


Figure 4.68: Proposal of the Undersecretariat of Green Infrastructure and Ecological Structure for the Implementation of the Re-naturalization Plan for Medellín.

4.9.2 Key Actors

On the strategic role of the Ministry of the Environment:

- The Leadership role of the Ministry of the Environment is clear in the normative mandate, not only at the operational but also strategic level. However, the existing structure and division of functions across a number of areas is not suitable for large-scale delivery of NBS.
- For this reason, and due to the growing importance of the issue for the city, in social and environmental terms, it is considered desirable to unify in an Undersecretariat of Green Infrastructure all the personnel currently dispersed in different Secretariats with tasks and functions in relation to green infrastructure and ecological structure.

- If a unified undersecretariat is not selected, an alternative would be to increase the capacity and financing of the Forestry Committee to support planning and monitoring of all of the public interventions, ensuring more coordinated and effective action.

On the key actors for the Medellín Re-naturalization Plan:

- Key public actors in leadership roles for planning and execution: Secretariat of the Environment, Secretariat of Physical Infrastructure, Administrative Department of Planning, Secretariat of Health.
- Key public actors in technical support roles for the generation and qualification of green infrastructure and the implementation of NBS: DAGRD, APP, ISVIMED, EDU, Jardín Botánico de Medellín.
- Key public actors in technical support roles for monitoring, monitoring, control and authority: Secretariat of Management and Territorial Control, Secretariat of Security and Coexistence, Ministry of Finance, Secretariat of Government, Police Inspections, National Police, among others.
- Key public actors in administrative support and social appropriation roles: Secretariat of Supplies and Supplies, Secretariat of Youth, Secretariat of Women
- Key public actors in technical and financial support roles: Metropolitan Area of the Aburrá Valley, Corantioquia.
- Key public actors in financial and political support roles: Medellín Council, Comptroller General, Personería.

On the relevant bodies for intra- and inter-institutional coordination:

- Key Instances of Articulation: Strategic Direction Council of the POT, SIGAM Committees, Inter-sectoral Advisory Commission of Public Space (currently the SMA does not participate in it)



4.10 Co-creation

The new development models propose the collective construction of the sustainable city, in which community participation is essential for decision-making. According to Article 79 of Colombia's constitution, "All people have the right to enjoy a healthy environment. *The law shall guarantee the participation of the community in decisions that may affect it.* It is the duty of the State to protect the diversity and integrity of the environment, to conserve areas of special ecological importance and to promote education for the achievement of these ends."

It is clear then, the right that all Colombian citizens have to participate in the decisions that affect them and in this specific case to participate in decisions related to the environment.

The development of the participatory process of the RUP is part of the Economic and Participation Strategy, which includes:

- Development of participatory meetings with economic and financial actors
- Development of participatory meetings with community actors
- Development of participatory meetings with academic actors
- Definition of participation mechanisms
- Articulation with the management model and with the financial strategy
- Definition of participation indicators
- Articulate with the Plan and the Management Model
- Development of participatory meetings with economic and financial actors

Considering both the national legislation and the postulates and methodological guidelines of the URBAN GreenUP, the participatory process of community actors began on August 6 2020, around the construction of the Re-naturalization Plan, with the workshop "City challenges and Nature-based Solutions", in this document the findings, challenges and approaches of community leaders around the green of the city are related.

4.10.1 Participation in the URBAN GreenUP project

From the methodological guidelines of the URBAN GreenUP, the participation processes must be present throughout the process, that is, for the duration of the planning of actions, since it is at several levels that the intervention of community groups, governmental and non-governmental agencies, companies and other parties is stipulated.

As benefits of participatory processes from the URBAN GreenUP, four stand out, namely:

1. "Fostering a sense of ownership: Direct experience of nature is crucial for the development of responsible attitudes and stewardship towards the natural environment (Mabelis and Maksymiuk, 2009). This immediate experience is achieved with optimal benefit when people participate in the co-creation of urban green spaces. If the diverse perspectives and values of stakeholders are not taken into account, the use of green space may be limited and the misuse and damage of green facilities and infrastructure, creating a financial burden on local government (Van Herzele et al 2005; Xi-Zhang, 2012). Not only can public stewardship and support reduce ongoing maintenance costs (Van Herzel et al, 2005), but it



is imperative to keep urban green spaces in good condition (Mabelis and Maksymiuk, 2009).

2. Everyone's needs can be better met: The traditional top-down planning approach has been criticized in planning processes, as it can be based on professional assumptions rather than the needs of users. These assumptions often fail to take into account the diverse needs of different social groups (Xi-Zhang, 2012). Co-creation involves the inclusion and empowerment of a variety of stakeholders (IAP2, 2014). Co-creation is defined as participation and cooperation between community groups, government and non-governmental agencies, businesses and other stakeholders (Furlong et al, 2018).
3. Learning from each other and creating mutual understanding: According to cognitive consistency theory, it is difficult to reject a process in which one has actively participated (Sommer et al, 1994). Public and diverse stakeholder participation in ecological strategies can provide educational opportunities and generate greater awareness and understanding (Herzel et al, 2005). A successful green space will promote and reflect the identity and culture of a local community, and the best way to achieve this is by involving the community in the design and development process (Herzel et al, 2005) through joint design and joint implementation.
4. Improve the quality of decision-making using local knowledge: When public policy decisions are made without involving stakeholders, the opportunity to use community knowledge is lost. The enormous potential of the urban population is often underutilized, but it can contain the creative ideas, skills and power of people needed to care for green spaces and maximize their contribution to quality of life (Herzele et al, 2005). Engaging users, residents, and community groups is critical to the long-term success of urban forests, trees, and green spaces, as it maximizes the benefits these spaces provide (Herzele et al., 2005). Engaging users, residents and community groups is critical to the lasting success of green spaces and to maximizing the benefits these spaces provide, improving the quality of life of users (Herzele *et al.*, 2005)."

4.10.2 Workshops

For workshop 1 on August 6, out of respect to the positions and ranks established in the city in the environmental area, the call for the leaders of the environmental tables began, starting with the zonal coordinators, then with the communal coordinators and ending with the leaders of bio-territorial tables.



| ZONA | NOMBRE | COMUNA | CARGO |
|----------------------|---------------------------|---------------------------|---|
| 1. NORORIENTAL | Gloria Bustamante | 1, Popular | Coordinador |
| | Luz Marina Gonzalez | 1, Popular | apoyo |
| | Rosalbina González | 1, Popular, Santo Domingo | apoyo |
| | Gloria Edilma Vargas | 1, Popular- Santa Cecilia | apoyo |
| | Obeiro Urrego | 1, Popular- Popular 1 y | apoyo |
| | Beatriz Elena Arcila | 1, Popular- El Compromiso | apoyo |
| | Arellys Rueda | 2, Santa Cruz | líder ambiental |
| | John Jairo Cañola | 2, Santa Cruz | Coordinador |
| | Anibal Muriel | 3, Manrique | coordinador |
| | Ángela Villa | 4, Aranjuez | Coodinadora |
| 2. NOR OCCIDENTAL | Jorge Arrieta | 5, Castilla | Coordinador |
| | Eusebio Bedoya | 6, Doce de Octubre | Mesa bioterritorial de la Esperanza-coordinador |
| | Marlon Carmona | 6, Doce de Octubre | Coodinador |
| | Fernando Castañeda | 7, Robledo | Coordinador |
| 4. CENTRO ORIENTAL | Leon Manrique G. | 9, Buenos Aires | Coordinador |
| | Deisy Ibarbuen | 10, La Candelaria | Coordinadora |
| 4. CENTRO OCCIDENTAL | Patricia Bahamon | 11, Laureles- Estadio | Coordinadora |
| | Germán Tobón | 12, La América | Aula ambiental |
| | Sergio Rúa Álvarez | 12, La América | Coordinador |
| | Yuliana Chica | 13, San Javier | Coordinador |
| 5. SUR ORIENTAL | Diego Rúa | 14, El poblado | Coordinador |
| 6. SUR OCCIDENTAL | Jorge Humberto Ortiz Rave | 15, Guayabal | Director |
| | Margarita García Valencia | 16, Belén | Coordinadora |

Table 4.23: Leaders of the environmental tables for workshop 1

In the call process initially a first call of invitation to participate in the workshop was made, then the Ecard was sent to each of each of the guests, for which it was necessary to create groups.

For workshop 2 held on August 13, the members of the PROCEDES -Citizen and community projects of environmental education and the environmental tables of the corregimientos of Medellín: Altavista, San Antonio de Prado, Palmitas and Santa Elena were invited.

| Fecha | Hora | N° asistentes | Asistentes Comunes | Convocados | Plataforma |
|--------------|--------------|---------------|--------------------|--------------------------------------|-----------------|
| 6 de agosto | 4:00-6:00 pm | 31 | 23 | Mesas ambientales urbanas | Google Meet |
| 13 de agosto | 4:00-6:00 pm | 19 | 14 | Mesas ambientales rurales y PROCEDAS | Microsoft Teams |

Table 4.24: Summary table of the participatory process



Project of eco-elertas of the commune 6.

This project delivered ecological gardens in commune 6 in partnership with the community.



Figure 4.72: Photos of community projects in commune 6

4.11 Financial strategy

The objective of the financial strategy within the framework of the re-naturalization plan for Medellín is to determine the most appropriate instruments, through which stable and sufficient resources can be generated in the long term that allow the generation, maintenance and recovery of green spaces.

This strategy becomes important to the extent that increasing the budget for the financing of green becomes a challenge for municipal administrations, given that the greatest resources come from current income, which can limit the objective of increasing this type of spaces and even more, to enjoy stable resources for the maintenance and qualification of them. Therefore, it is necessary to review the instruments that would increase the green areas within the municipality, as well as those that would contribute to their maintenance, in order to specify a proposal where different tools are articulated (from public and private resources) that allow creating synergies around the common purpose of increasing and maintaining green spaces.

As explained by Fernández and López (2019), ... "during the last administrations there has been a high investment in new infrastructure and renovation of existing spaces; but issues such as investments in the management and operation of these spaces have not been fully resolved. From the planning of the different projects of public spaces, ways of addressing the sustainability of these over time must be considered. The current panorama exposes a Medellín that in recent years developed and improved its urban conditions and public space throughout the territory; with projects at different scales and with positive impacts on communities. Now, that success of the public space can be appreciated through the dynamism and impact on the benefited communities; but it is also understood that the operation, maintenance and sustainability of urban projects over time plays an important role when it comes to making investment in public infrastructure."²⁹

Therefore, the RUP must propose various financing and maintenance alternatives for green spaces, which do not depend exclusively on current public resources, where private third parties and citizens in general can be involved, to achieve autonomy and sufficiency in resources.

It is important to note that this document was constructed from the results obtained in the Re-naturalization Strategy for Medellín, developed in 2019, in which an inventory of financing instruments was consolidated. Subsequently, within the framework of the RUPM, an evaluation of each instrument was carried out, based on meetings with key actors, which gave rise to guidelines and proposals focused on the sources of financing that will allow the generation, maintenance and qualification of green spaces.

²⁹ Fernández López, Alexander and Lopez Cortes, John Paul (2019). Structuring of a Public-Private Partnership Model for economic use of public spaces in Medellín. -Case study Medellín River Parks first stage – EAFIT University- Master in Applied Economics. Medellín



4.11.1 Objectives of the financial strategy

As noted above, the overall objective of the financial strategy is the selection of stable and sufficient long-term instruments that allow the generation, maintenance and qualification of green spaces. To this end, the following are limited as specific objectives:

- Evaluate the current sources of financing that will have applicability in the future implementation of NBS and that consequently contribute to the generation, maintenance and qualification of green spaces.
- Propose direct channels to operationalize the sources of financing with specific destination for green.
- Consolidate an inventory of green jobs and potential operators.

4.11.2 Methodological route

The methodological proposal for the analysis of the financial instruments and mechanisms that will promote investment in green spaces, is based on an approach to a state of the art that succinctly presents the offer of financing instruments (currently used and potential) for the generation and maintenance of green, and that involves public and private instruments, in order to achieve articulation between sources and increase the monetary and land resources available for investment in generation, maintenance and qualification.

Based on the available offer of sources and financing mechanisms, the actors to be involved are defined considering their role and participation in the implementation of these mechanisms; and through meetings with them, the impact of the instrument is evaluated in terms of green soil generation, maintenance of green areas or green infrastructure; limitations are identified in its implementation, as well as the potential to involve third parties in the management of resources for green. Based on these results, it is determined which instruments should be considered in the Re-naturalization Plan once there are specific intervention projects based on NBS nature.

Finally, the general guidelines for the implementation of the financial strategy are established, for which recommendations on the application of the prioritized instruments are built. Likewise, the potential operators of Nature-based Solutions are identified, which must be integrated into the plan as relevant actors.

Figure 4.73 shows the methodological scheme proposed, and that will allow to define the portfolio of instruments for the financial management of the green.



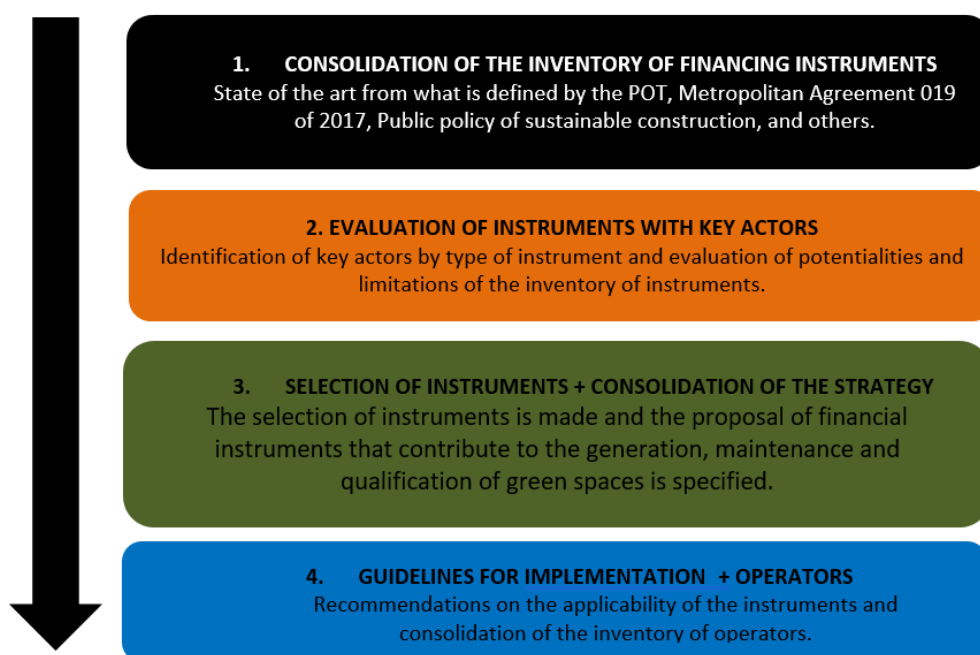


Figure 4.73: Methodological scheme

It is important to consider that the selection of a set of financial instruments that should be enhanced to increase green areas in the city, as well as the resources for their generation, maintenance and qualification, requires a future articulation with the conceptual model to be built within the framework of the RUPM, particularly the criteria for prioritizing challenges and solutions based on the NBS nature, to the extent that the instruments should discuss the specific context of the solutions proposed at the city scale, as well as consider elements associated with soil classification and conservation values (identified ecosystem services) for the areas where NBS should be implemented. Once the results of the conceptual model are available and the specific solution(s) to be addressed are clear, the particular business case for said NBS must be developed.

The detailed exposition of this methodology is presented in Annex 7.

4.11.3 Selection of instruments and consolidation of the financial strategy

Based on the information collected in our analysis, the financial instruments that should be enhanced within the framework of the RUP are presented.

Instruments to be promoted for the generation of green public spaces

The instruments that most efficiently aim at the generation of green public spaces correspond to the financing instruments of the POT, associated with urban obligations of areas of public cession, and the sale and transfer of construction and development rights. Both instruments with specific destination for the subsystem of public space for recreation and encounter, aim at the realization of collective rights to public space and heritage. Likewise, the instruments associated with the participation in the surplus value and the contribution in valorisation are included as priorities.

It is important to recognize, as stated in Agreement 048 of 2014, that the subsystem of public space for recreation and encounter is associated with the main and complementary ecological structure, and includes the green areas associated with articulating and meeting public spaces, seeking to generate a harmonious relationship between man and nature, especially in the areas of greatest pressure on ecosystem services, so it generates synchrony with the objectives of the RUP.

As noted above, these instruments have the potential to be incorporated into the RUP, since they are regulated, are subject to collection and have a specific destination for green. However, it is necessary to create more expeditious channels that allow the SMA to dispose of the monetary resources or land generated by them. This implies greater management and accompaniment before the Strategic Steering Council of the POT (CDE), and before its Technical Committee (first instance evaluation), which translates an effort of the SMA in terms of greater human and financial resources to accompany the management process, especially when the RUPM is not prioritized as a specific project of the PDM nor is it registered in the project bank of the POT. So, it is important to generate within the RUPM a specific project that aims at these areas.

In this regard, it should be considered that the future regulation of Agreement 047 of 2015 (Through which the "strategy for the generation and maintenance of public spaces that promote tree and green soil compensation in the municipality of Medellín" is institutionalized), becomes a potential to create a binding link with the financing strategy of the RUP. This agreement has exclusivity in the management of green, and would allow in the medium and long term the generation of resources with a view to increasing the green spaces of the city. To do this, a percentage of the collection associated with the selected instruments must be established, with a specific destination for the green (urban obligations/ assignments, sale and transfer of construction and development rights, contribution in valorisation and participation in the surplus value) considering, in the case in which it applies, the destination in the area of interference of the project of generation of public space that causes the benefit.

Considering the above, the way to manage resources to increase green land from the incorporation of these four instruments of the TEP, must be established through the formation of a common fund or account, from which resources of specific destination are managed and that correspond to a percentage of the selected instruments. This implies a charge for subsystems of the PE component according to the specific destinations of each instrument.

The appropriation of a percentage of the collection of these instruments of the POT with a view to increasing green spaces, would aim to meet the objectives of the PDM 2020-2023 especially in the component of ecological urbanism, associated with the goal of 320,197.52 m² of effective public space generated, (which represents an increase of 157,690.22 m² with respect to the baseline), which include in some portion of green areas. As well as the public space maintained and built within the framework of the public space program for the collective enjoyment and territorial sustainability of the PDM.

For the consolidation of this component of the financial strategy, it is necessary to adopt indicators that allow the different actors with competence in the green to carry out monitoring



and evaluation of the efficiency of the instruments applied, so as to guarantee that the percentage established per collection with specific destination for the green, is captured and executed, in association with the intervention projects proposed by the RUP.

Finally, it is important to mention that, according to the medium-term Fiscal Framework of the municipality, the item associated with green areas and equipment according to the provisions of Agreement 48 of 2014 (from urban obligations) amounted to \$ 41,184,600,768 for the year 2018. However, there is no projection for future years, so it is not possible to define what would be the impact of the collection of a percentage of the instruments of the TEP on the management of green.

Instruments to be promoted for the maintenance and qualification of green public spaces

According to the evaluation carried out, the instruments that most aim to generate resources for maintenance and qualification of green public spaces are associated with the Economic Use of Public Space (AEEP) and a scheme for sponsoring green areas (Sponsor Plan).

- Economic use of public space – AEEP

The instrument associated with the AEEP represents a potential for the RUPM, insofar as it enables the participation of private third parties in the management and qualification of green, has current regulations and is an instrument with a track record in implementation by the agency for landscape management, heritage and Public-Private Partnerships - PPPs.

The contracts that would apply to the management of public space and that would enhance the participation of third parties for the implementation of NBS correspond to: Contract for the maintenance of public space and Contract for the administration and maintenance of public space with economic use in kind.

- Public space maintenance contract: Defined by Article 540 of Agreement 048 of 2014. "It is the legal act by which one or more constituent elements of the public space are delivered to legal persons for their maintenance and preservation, through actions such as cleaning, pruning, replanting, minor repairs and the like. In this contractual modality, the consideration in favour of the legal person or contractor may be the permit for the installation of visual outdoor advertising in small elements or formats, according to current regulations. "

This contract can be executed both on hard floor and on green floor, so it is susceptible to be implemented in the management of green and the implementation of NBS. It empowers the third party to make improvements on the public space it enjoys and generate economic use for the municipality.

- Contract for the administration and maintenance of public space with economic use in kind: Defined by article 13 of Decree 522 of 2018. From which the administration contract with economic use of public space is regulated (Contracts with private entities with or without profit, in which there is no state participation, or natural persons): "The private entity or natural persons interested in the conclusion of the administration contract with economic use of the public space must submit a proposal



that includes the determination of the area susceptible to the contract of administration and maintenance of the public space, in which the areas to be occupied for the economic use and the costs of supporting the spaces object of the administration contract are indicated. The remuneration in favour of the Municipality of Medellín may be in kind and / or in money, in any case in accordance with the occupied area and the object of economic use of the public space. However, for the purposes of stipulating the respective value of the remuneration, the equivalence in money will be considered, related to the costs of administration, maintenance and economic use of public space. "

From this contract, a third party can develop the categories that apply of the AEEP, regulated by Decree 2229 of 2019 and in compensation implements NBS, maintains the public space and the green area. As indicated in Decree 522 of 2018, prior to the conclusion of the contract, the interested party must present the occupation project with the costs of administration, maintenance and monthly maintenance, as well as the areas to be occupied with the different modalities of economic use, both temporary and transitory that are planned to be carried out in the term of the contract, in order to determine the value corresponding to such use. In this sense, the municipality of Medellín would not receive monetary use, but compensation in kind that will enhance the maintenance and qualification of the green.

As an additional resource, for the maintenance of green spaces, it is proposed to allocate a percentage of the resources of the exclusive destination fund for transitory / permanent activities of the AEEP; considering that the integral projects of intervention of the landscape, in which the green component is involved, especially for the areas where the AEEP is made, have the potential to be subject to monetary contributions. Since it corresponds to an instrument of recent application, it does not have a robust portfolio of projects for the destination of compensations. However, the implementation of NBS can operate as an investment channel for this type of contract.

To achieve this participation, it is a priority that the Ministry of the Environment take an active part in the Inter-sectoral Advisory Commission on Public Space of the APP Agency. Although Decree 2148 of 2015 empowers her as a member of said Commission, a more active role is required in this instance to manage resources to the extent that the Commission has among other functions, to prioritize projects for the qualification, sustainability, maintenance and economic use of public space and direction of resources. It should be clarified that the intervention initiatives to be formulated by the RUPM from the implementation of NBS could be financed with the resources of the AEEP Fund, due to the projects that the PPP Agency prioritizes do not necessarily have to be immersed as PDM projects, but should meet the prioritization criteria that are mostly associated with interventions on physical infrastructure and in which the Green component is considered to be an integral part of the landscape.

Finally, it is highlighted that according to the medium-term municipal fiscal framework, the items collected by the AEEP fund in 2019 corresponded to \$ 2,927,481,749 while the projection to 2020 stood at \$ 2,988,709,193. Although it does not yet constitute a robust fund, a percentage of these resources would come to add up for the maintenance of the green.



- Scheme of sponsorship of green areas

It corresponds to the second instrument that would enhance the implementation of NBS, as well as the maintenance and qualification of green spaces. This would be developed from an agreement of wills between the Municipality and a third party, which can potentially receive the following benefits:

- Tax benefits within the framework of Decree 2205 of 2017 and Resolution 509 of 2018 of the Ministry of Environment and Sustainable Development, for investments in environmental control or conservation and improvement of the environment.³⁰ In this sense, companies that make investments within the framework of projects aimed at the control of the environment or the conservation and improvement of the environment are empowered to obtain a discount of income tax corresponding to 25% of the investments made in the respective taxable year in control, conservation and improvement of the environment, in accordance with the provisions of article 255 of the Tax Statute.

Companies must carry out the procedure before the competent Environmental Authority (AMVA), certifying the object and purpose of the investment made, and with the verification of the environmental benefits obtained with it. That in the case of the implementation of NBS will be associated with the enhancement of ecosystem services and the contribution in the mitigation of the city challenges proposed within the framework of the URBAN GreenUP Project.

- Marketing in public space (advertisement): As the "Godfather Plan of green areas" program was formulated within the framework of the "Development Plan 2016 – 2019 Medellín Cuenta con Vos", the third donor could exercise the benefit of the installation of a billboard that allows advertising about his company, brand or institution within the area to be intervened. Access press releases in which free press is made in front of the media. As well as the promotion of the sponsor company within the events of the Municipality of Medellín and advertising in public spaces with the presence of the sponsor's brand as an environmental participant.
- Marketing Digital
- Contribution to Corporate Social Responsibility: the company generates a positive externality that can be disclosed and evidenced in the sustainability report based on the environmental performance indicators of the Global Reporting Initiative -GRI.

Taking into account that the strategy proposed in the last administration managed to characterize at the level of detail 10 of the 34 ecoparks of ravines of the city, from topographic survey, forest inventory, and maintenance costs, this scheme can capitalize on this knowledge for its formulation and implementation. However, new potential sponsorship areas must be

³⁰ See Decree 2205 of 2017. Article 1.2.1.18.53. numeral h. In this establishes that investments in the framework of projects aimed at the control of the environment or the conservation and improvement of the environment, entitle to the income tax discount.



defined, which are part of the main ecological structure, and which at this time are not being intervened by resource constraints.

The sponsorship exercise developed in the last administration evidenced a limitation in operational terms, associated with the absence of a fund or specific figure from which the municipality can capture resources for sponsorships. Therefore, the formation of a fund or a structure with the Ministry of Finance must be reviewed to generate a figure that allows the third party to deliver the resources for the maintenance of the green zone.

It should be considered in the planning of the sponsorship scheme, longer deadlines, so that the resources to be captured are sufficient to obtain qualification (adaptations) of the space if required. Thus, the Ministry of the Environment should be the governing body of the intervention policy on green space, so that the intervention carried out by the third party on green space maintains the technique and planning that the municipal administration has developed for this purpose, in articulation with the Botanical Garden of Medellín.

The tax benefit that the third party can access once the intervention on the public space has been carried out must be the letter of presentation and positioning of this figure, so that the third party finds an incentive to make the investment. Especially when the intervention on green public space is based on solutions based on nature- NBS, which have a direct and positive impact on environmental quality.

It is important to highlight that, since these green financing proposals are being designed to be implemented in the medium or long term, it is important to incorporate the criteria defined by the RUPM to the projects that develop the pot city model. In this sense, both the projects prioritized by the PDM, as well as the investment projects based on the compensations by the AEEP should incorporate elements that integrate the green. In this sense, it is necessary to consider the strategic projects of the city, for the implementation of NBS (light rail of the 80, Centrality of the north, District of innovation and other projects with the APP). This implies articulation and training of different dependencies (SIF, APP, among others), on the elements proposed by the URBAN GreenUP project within the framework of the construction of the RUPM, as well as on the categories of NBS that can be implemented in accordance with the provisions of the challenge prioritization model and NBS.

Finally, it is important to note that, within the framework of the meetings held for the financial strategy, it was not possible to establish contact with the Secretariat of Supplies and Services, as well as with the legal component of the SMA in charge of the formulation of the Godfather Plan of the previous administration. Therefore, it was not possible to delve into the channel of operation of the instrument and the type of agreement that must be established with the third party. It is necessary to review the procedure that empowers the adoption of sponsorships and the channel through which the public good is transferred for its management, because complexities are presumed from the administrative and legal that limit its potential as an instrument to involve third parties in the management of resources for the green. Likewise, the type of agreement to be signed with the donor must be defined, and the channel that operationalizes the scheme.



4.11.4 Guidelines for the implementation of the financial strategy

The financing instruments selected within the framework of the RUPM tend to a diverse financing strategy for green, insofar as it involves land management instruments, economic use of public space and a sponsorship scheme that will allow municipal resources for generation and private resources for maintenance and qualification.

It is necessary to increase the actions of resource management through the Strategic Direction Council of the POT by the secretariats with interference in the green (SIF and SMA) because the resources for the realization of the TEP occupancy model are managed through this instance and the green component is included in it. Likewise, it is a priority to generate within the RUPM a specific project that points to the items selected as priorities (urban obligations of areas of public cession, and the sale and transfer of construction and development rights, participation in the surplus value and contribution in valorisation).

It is necessary to adopt indicators that allow the different actors with competence in the green to carry out monitoring and evaluation of the efficiency of the instruments applied in such a way as to guarantee that the percentage established by collection with specific destination for the green (of the instruments of the TEP), is captured and executed, in association with the intervention projects proposed by the RUP.

It is a priority that the Ministry of the Environment take an active part in the Inter-sectoral Advisory Commission on Public Space of the PPP Agency. To have an impact on the management of resources of the fund for the economic use of public space, and on the prioritization of projects that involve the green component as a fundamental part of the landscape.

To precisely define the sponsor plan scheme, it is necessary to delve into the instrument's operation channel, the management of the public good to be transferred to the third party, the type of agreement that must be established with the third party, and the operational scheme of the same and that includes duration, number of maintenance and the management of the qualification and maintenance of the green space by an expert third party.

Finally, it will require the institutional will of the dependencies with interference in the green and in a particular way of the SMA to assume with commitment the objectives, projects and goals that the RUP establishes, and that will imply greater monetary and human resources, that allow to manage resources and monitor the impact of the interventions.



4.12 Landscape planning and management guidelines

Based on the institutional, financial, and technical analyses carried out within the framework of the strategy formulation process, 15 general guidelines for landscape planning and management are proposed. These are divided into guidelines for NBS generation, maintenance and planning, which we discuss respectively below.

4.12.1 Guidelines for generation

- Create a monitoring table for the execution of urban obligations, which tends to the correct use of them for the generation of new NBS. Led by the Secretariat of Territorial Management and Control and the Secretariat of the Environment.
- Resume the strategic and operational orientations of the planning process carried out by the Metropolitan Green Belt, seeking to identify (or update the inventory) opportunity properties in peri-urban areas and apply the land management instruments that allow their acquisition for environmental conservation objectives, risk management, and recreational/tourist use. Led by the Administrative Department of Planning and the Secretariat of the Environment.
- Generate where it is most necessary, that is, address the territorial deficits clearly known since the formulation of the Master Plan for Green Public Spaces, to favour access for a large number of population in the most deficient neighbourhoods. Led by the Secretariat of the Environment and the Administrative Department of Planning.
- Establish a package of economic incentives for the establishment of Nature-based Solutions in the areas of urban consolidation and urban redevelopment, applying the strategies proposed by the Metropolitan Policy of Sustainable Construction, and the catalogue of Nature-based Solutions provided by the URBAN GreenUP project. They lead the Ministry of Finance and the Ministry of the Environment.
- Ensure compliance with the Public Space Manual and the Urban Forestry Manual to increase and improve green public space on the occasion of public interventions and works. Led by the Secretariat of Infrastructure and the Secretariat of the Environment.
- Consolidate and strengthen the Forestry and Landscape Committee as the coordinating body for urban and rural green management, and the Urban Tree System (SAU) as a technical instrument for the management of information on urban trees and green public space. They lead the Ministry of the Environment. Administrative Department of Planning, and Secretariat of Physical Infrastructure.
- Implement a program of restitution of public space focused on areas of recreation to ravines, to reintegrate citizens in these areas of public domain. Led by the Administrative Department of Disaster Risk Management, the Secretariat of Territorial Management and Control and the Secretariat of the Environment.



4.12.2 Guidelines for maintenance

- To form and finance the operation of a work brigade in training and citizen pedagogy for the defence and care of public space, in order to increase awareness about the elements of public space, urban infractions, and restitution processes. Led by the Ministry of Education, the Secretariat of Management and Territorial Control, and the Secretariat of the Environment.
- To form a system of follow-up and monitoring of the modalities of economic use of public space that allows to study and refine the possibilities they offer in specific areas of the city. Led by Administrative Department of Planning, and Secretariat of Environment.
- Actively link community leaders (Care Groups, Environmental Tables, Community Action Boards, Merchant Groups, Private Security Companies, among others) with the management of urban and rural greenery, through effective channels of communication and dialogue, especially for activities to identify priority areas of action and defence of green public space. Led by the Secretariat of Social Development, the Secretariat of Territorial Management and Control, and the Secretariat of the Environment.
- Discuss, design and include a program of maintenance of green infrastructure and ecological structure in the review process of the Municipal Environmental Plan 2020-2032 and the formulation of the Development Plan 2020-2023. Led by the Ministry of the Environment and the Ministry of Health.
- Generate a package of incentives (in money or kind) for the neighbourhoods with the best front gardens, which promotes the recovery, and citizen care of these elements of the ecological infrastructure of the city. Led by the Ministry of Finance and the Ministry of the Environment.
- Carry out research applied to the evaluation of costs of establishment and maintenance of green areas associated with public meeting spaces, mobility system, and drainage retreats, in order to generate technical strategies for the optimization and efficiency in the maintenance of green public space. Led by the Ministry of the Environment.

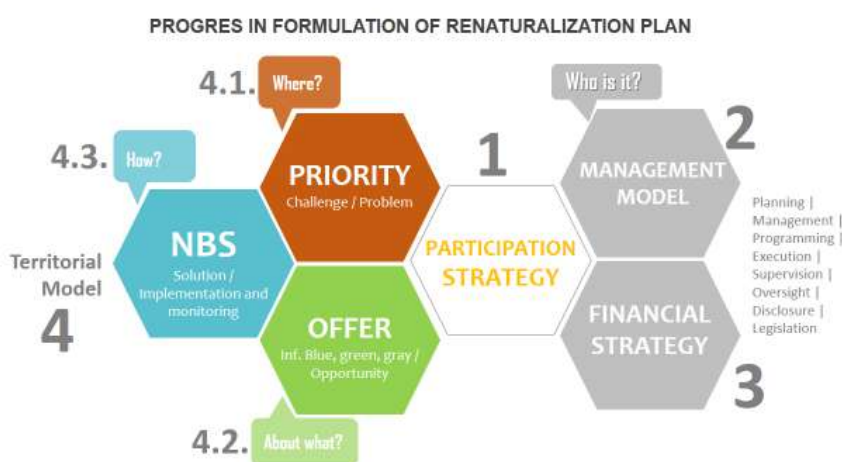
4.12.3 Guidelines for planning

- Develop a cartographic model of viability of each type of NBS, based on its technical characteristics and the territorial demands of specific ecosystem services, as a decisional tool to determine principles and emphasis of landscape design to an adequate resolution. Led by the Secretariat of the Environment, the Ministry of Health, and the Secretariat of Physical Infrastructure.
- Increase the staff attached to the different secretariats related to the management of green infrastructure and the ecological structure of Medellín, especially the Secretariats of Environment and Territorial Management and Control.



4.13 Integration: how we will deliver the RUP

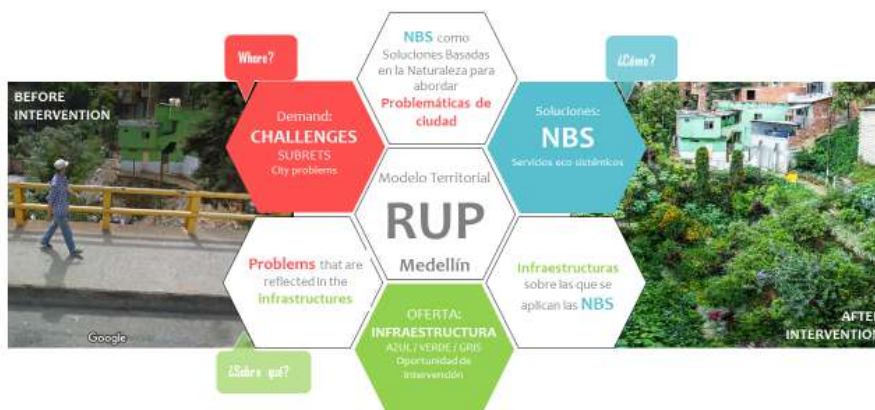
The Re-naturalization Plan proposes to develop an institutional management model identifying actors, defining functions, roles and competences for green management. A prioritization model for the spatialization of potentially critical areas of the city that need to be intervened through Nature-based Solutions. A financial strategy determining the economic instruments with greater viability in the long term that allows the generation, maintenance and recovery of green spaces. Establish a monitoring and follow-up system for the implemented Nature-based Solutions and a participation strategy through processes of co-creation with private actors, institutions, citizens and academics.



| General structure of the Territorial Model



Estructura conceptual del Modelo Territorial para el Plan de Renaturalización de Medellín



APPLICATION OF THE PROPOSED METHODOLOGY, CASE STUDY



Figure 4.74: RUP institutional management model

CATEGORIES AND TYPOLOGIES OF NBS

Catalogue of the NBS proposed by the urban project URBAN GreenUP: The city of Medellín classifies the typologies by categories. It establishes 13 categories associated with green infrastructure (Green colour), grey infrastructure (orange), blue infrastructure (blue).



Figure 4.75: NBS classification into 13 categories

ANALYSIS OF CITY CHALLENGES

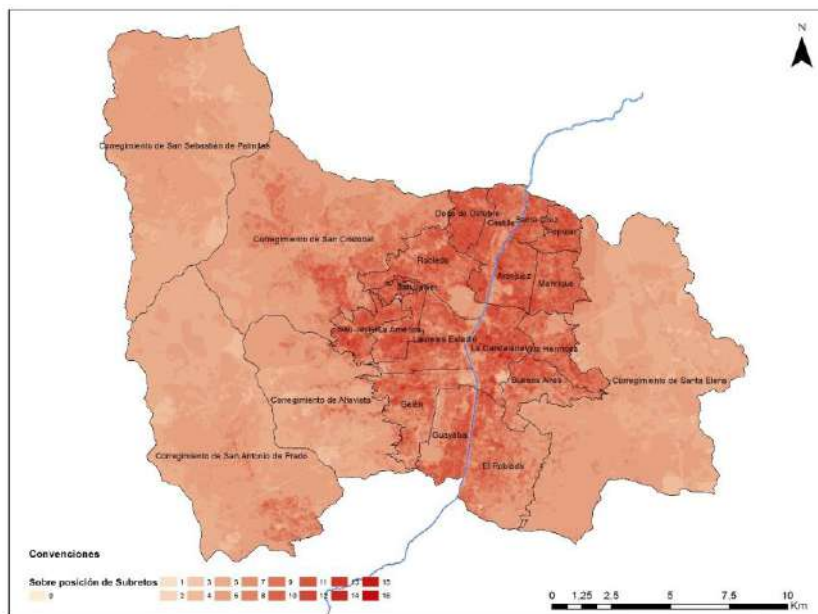


Figure 4.76: Superposition of the challenges of the municipal polygon

This map contains the results of the over position of the challenges in the mesh of the municipal polygon composed of a thirty by thirty meter cell. The highest number of superimposed sub-challenges corresponds to 16 and, in general, the range oscillates between 0 and 16. The total of 30x30 cells relate about 420,552 data for the entire municipality.

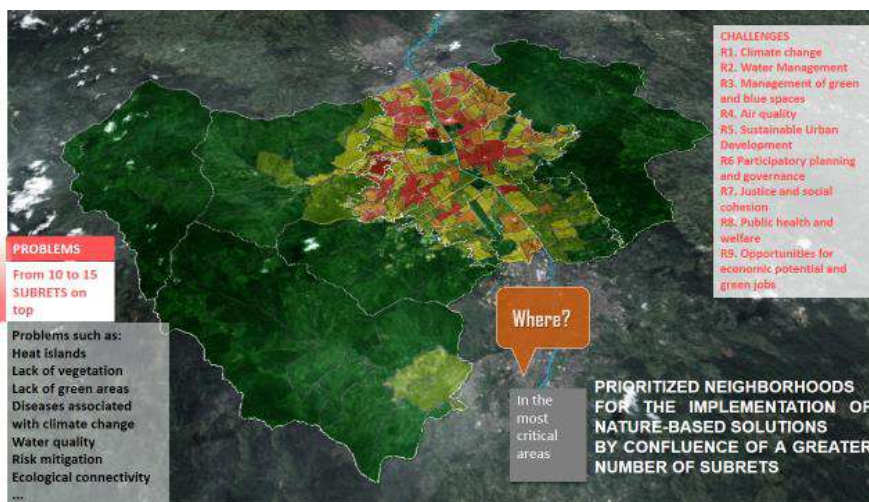


Figure 4.77: Prioritized neighbourhoods for the implementation of NBS

This map corresponds to the spatial identification of 9 challenges and their associated sub-challenges in order to be interpreted as the problems that the city must address, resulting in the critical and strategic areas where it must intervene through Nature-based Solutions.

Here we see the communes prioritized and prioritized neighbourhoods.

4.13.1 Demonstration of the Proposed Methodology

Medellín's early actions have been implemented in some areas that correspond to those where the results of the model have shown high levels of priority due to the number of overlapping challenges.

Next, the results obtained by the model for the communes with a high rank in the average of over-position of sub-challenges are observed

| COMUNA | Prom. Suma Subreto | Rango Prom. Suma Subreto | Prom. Suma Reto | Rango Prom. Suma Reto |
|-------------------|--------------------|--------------------------|-----------------|-----------------------|
| Doce de Octubre | 10,0 | 3 | 3,4 | 3 |
| Popular | 9,7 | 3 | 3,3 | 3 |
| Aranjuez | 9,5 | 3 | 3,2 | 3 |
| San Javier | 9,5 | 3 | 3,1 | 3 |
| Manrique | 9,4 | 3 | 3,1 | 3 |
| La América | 9,4 | 3 | 2,8 | 3 |
| La Candelaria | 9,4 | 3 | 3,1 | 3 |
| Santa Cruz | 9,3 | 3 | 3,1 | 3 |
| Castilla | 9,0 | 3 | 3,0 | 3 |

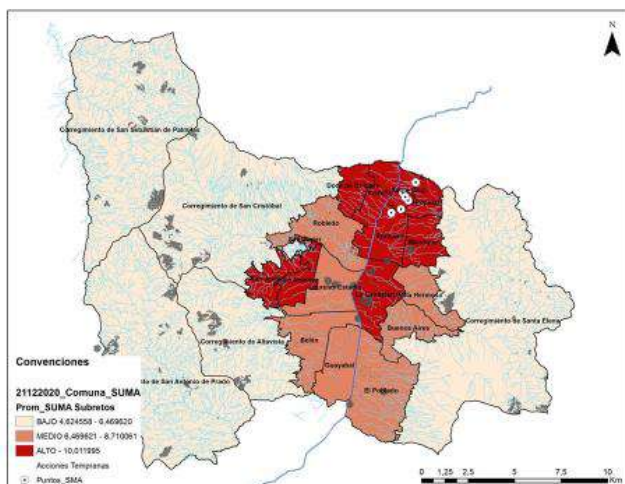
Table 4.25: Average ranges of over-position of sub-challenges in communes in relation to the early actions carried out by the municipal administration

The municipalities of the north-eastern zone of the city such as Popular, Santa Cruz and Aranjuez are within a high range for the prioritization of intervention due to the average of over-position of sub-challenges. Given the above, they should be reviewed in detail and consider that the Medellín SMA has developed different early actions in them, particularly in Santa Cruz.



Average ranges of over-position of sub-challenges in communes in relation to the early actions carried out by the municipal administration

The municipalities of the northeastern zone of the city such as Popular, Santa Cruz and Aranjuez are within a high range for the prioritization of intervention due to the average of over-position of sub-challenges. Given the above, they should be reviewed in detail and consider that the Medellín SMA has developed different early actions in them, particularly in Santa Cruz.

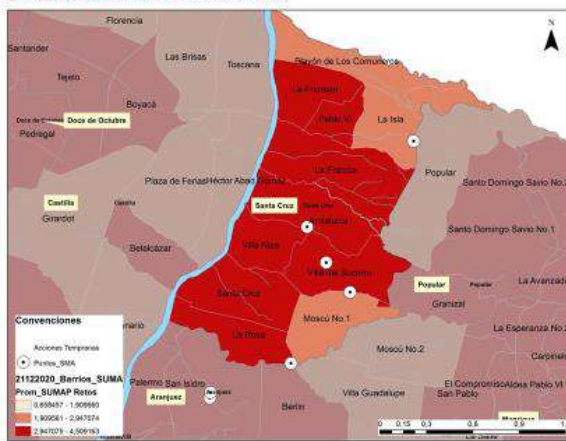


Application of the proposed methodology, case study

Step 2] Identificación de neighborhoods of the selected commune in a critical state

Within the early interventions located in the Santa Cruz commune (Villa del Socorro and Andalucía neighborhoods) they coincide with high priority ranges.

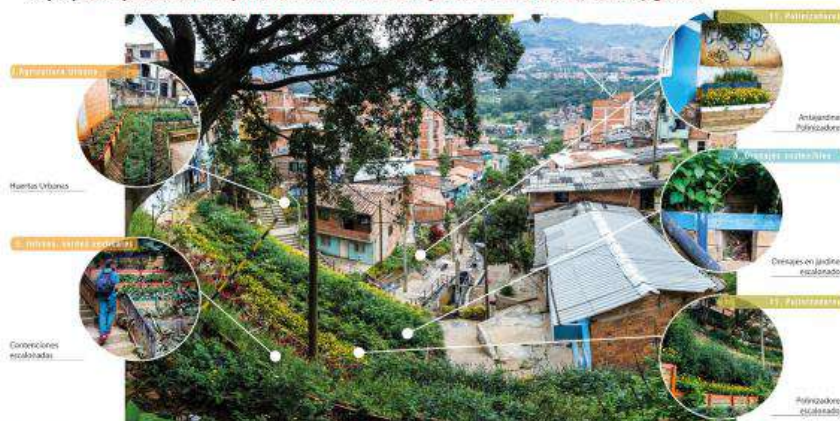
For the case analysis, the Andalucía neighborhood was selected, which is located in a central location of the community and the interventions proposed there could articulate and connect the sector in physical and ecological terms.



Average ranges of over-position of sub-challenges in neighborhoods of the Santa Cruz Commune in relation to the early actions carried out by the municipal administration

Application of the proposed methodology, case study

Step 3] Identificación de la oferta territorial desde las infraestructuras verdes, azules y grises



Recovery of creek retreat areas from light interventions by the Secretary of the Environment of Medellín, Quebrada Juan Bobo.

Application of the proposed methodology, case study

Step 3| Identification of the territorial offer from green, blue and gray infrastructures

Within the green infrastructures in areas close to the intervention, Residential Green Zones are identified that are integrated into city centers, being a potential to physically connect the Juan y Bobo stream and the Blanquizala stream. Calle 107, a highly mixed corridor with the possibility of generating integrated interventions between public and private actors, in addition to locating the cable metro infrastructures on this same street, with the possibility of using the supporting structure of the cables and the stations as potential spaces for the implementation of NBS.

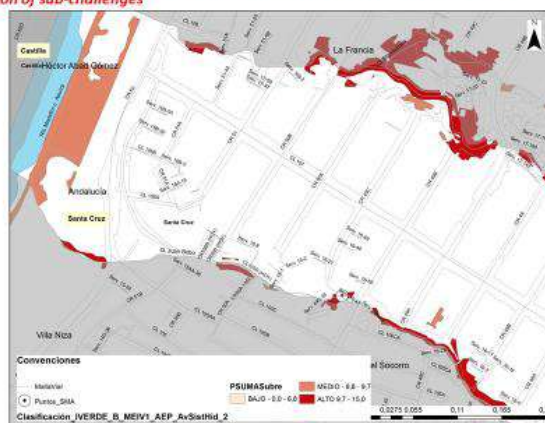


Green, blue and gray infrastructure available and 30x30 cells with over-position of sub-challenges in the Andalusia neighborhood in relation to the intervention initiative of the Ministry of the Environment

Application of the proposed methodology, case study

Step 4| Identification of the territorial offer from green, blue and gray infrastructures in relation to the most critical areas according to the superposition of sub-challenges

Classification according to the position of sub-challenges of the Green Areas of the Hydrographic System



Application of the proposed methodology, case study

Step 5| Selection of NBS categories for application in green, blue and gray infrastructures

Aerial view of a residential area with various NBS categories highlighted by callouts. The categories include: 1. Asientos de tecnología, 2. Árboles, vegetación, 3. Jardines, zonas verdes, 4. Muros Verde, 5. Pavimento Pijo, 6. Contenedores verdes, 7. Reforestación de canales, 8. Puentes verdes, 9. Rotomacías verdes.

List of NBS categories with a table with the Green Areas of the Hydrographic System.



Figure 4.78: Case studies of the application of the proposed methodology

4.14 Monitoring and follow-up system

Monitoring of the NBS typologies that will be implemented in the territory across the nine identified priority challenges. Prioritized indicators for Medellín for the NBS monitoring and follow-up system are as follows:

| CHALLENGES | TYPE OF INDICATORS | CODE | KPI Standard (Key Performance Indicators) |
|--|--------------------|--------------------------------------|--|
| CHALLENGE 1: ADAPTATION AND CLIMATE CHANGE | Chemical | CH0101 | Ton CO ₂ CARBON REMOVED by Ha |
| | | CH0102 | CO ₂ ton of CARBON REMOVED per year |
| | Physical | CH0105 | DECREASE IN TEMPERATURE |
| | | CH0108 | HEAT WAVE RISK |
| | Economic | CH0110 | Saving kWh PER YEAR |
| | | CH0111 | t SAVINGS C/a PER YEAR |
| CHALLENGE 2: WATER MANAGEMENT | Physical | CH0201 | RUNOFF COEFFICIENT |
| | | CH0204 | ABSORPTION CAPACITY (m ³ /m ²) |
| | | CH0205 | ABSORPTION CAPACITY (m ³ /tree) |
| | | CH0206 | TEMPERATURE REDUCTION |
| | | CH0207 | INTERCEPTED RAIN |
| | Chemical | CH0211 | NUTRIENT REDUCTION (Chemical Oxygen Demand, COD) |
| | | CH0212 | NUTRIENT REDUCTION (Biochemical Oxygen Demand, BOD) |
| | | CH0213 | NUTRIENT REDUCTION (Total Solids, OSH) |
| | Socioeconomic | CH0215 | IRRIGATION WATER SUPPLY |
| | | CH0216 | WATER REMOVED FROM THE WATER TREATMENT |
| Economic | CH0218 | WATER EXTRACTED FROM WATER TREATMENT | |
| CHALLENGE 4: MANAGEMENT OF GREEN AND BLUE SPACES | Space | CH0401 | DISTRIBUTION OF GREEN SPACES (m ² /capita |
| | | CH0402 | DISTRIBUTION OF GREEN SPACES (km bike lane/inhabitant) |
| | | CH0405 | ACCESSIBILITY TO GREEN SPACES |
| | | CH0406 | GREEN INFRASTRUCTURE CONNECTIVITY |
| | Social | CH0408 | RECREATION VALUES |
| | | CH0410 | QUALITY OF LIFE FOR THE POPULATION |
| | | CH0411 | PERCEPTION OF CONNECTIVITY |
| | | CH0412 | FOOD PRODUCTION |



| | | | | |
|---|-----------------|---------------|--|------------------|
| | Biological | CH0413 | POLLINATOR INCREASE | |
| | | CH0417 | SUSTAINABLE LOST SPACES | |
| CHALLENGE 5: AIR QUALITY | Physicists | CH0508 | AIR QUALITY PARAMETERS NO ₂ | |
| | | CH0505 | AIR QUALITY PARAMETERS O ₃ | |
| | | CH0501 | LEVELS OF PARTICULATE MATTER PER YEAR PM2.5 | |
| | | CH0502 | LEVELS OF PARTICULATE MATTER PER YEAR PM10 | |
| CHALLENGE 6: SUSTAINABLE URBAN DEVELOPMENT | Economic | CH0507 | ECONOMIC VALUES OF AIR QUALITY | |
| | Sociocultural | CH0602 | BENEFITS OF INTERVENTIONS | |
| CHALLENGE 7: PARTICIPATORY PLANNING AND GOVERNANCE | Social | CH0603 | ENERGY SAVINGS FROM INTERVENTIONS | |
| | | CH0701 | APERTURE | |
| CHALLENGE 8: JUSTICE AND SOCIAL COHESION | Social Cohesion | CH0703 | PERCEPTION OF CITIZENSHIP | |
| | | CH0801 | CRIME REDUCTION | |
| | | CH0802 | ENVIRONMENTAL AWARENESS THROUGH ACTIVITIES | |
| CHALLENGE 9: PUBLIC HEALTH AND WELL-BEING | Health | CH0803 | ENVIRONMENTAL AWARENESS THROUGH COMMUNICATIONS | |
| | | Psychological | CH0901 | RUIISO REDUCTION |
| | | CH0902 | INCREASE IN PEDESTRIAN AREAS | |
| CHALLENGE 10: ECONOMIC POTENTIAL OPPORTUNITIES AND GREEN JOBS | Economic | CH0903 | INCREASE IN CYCLES | |
| | | CH1001 | TAX REDUCTION | |
| | | CH1002 | JOB CREATION | |
| | | CH1003 | BUSINESS REVENUE | |
| | | CH1005 | CONSUMPTION BENEFITS | |

Table 4.26: Prioritized indicators for NBS monitoring in Medellín



5 Quy Nhon RUP

5.0 Abstract

Quy Nhon is a coastal city with its coastal geographical location, the impact of natural disasters and climate change is exacerbating along with the rapid urbanization process in recent years, the population and transportation traffic. The rapid increase in traffic has formed many hard-concrete works, lost green space and water surface in the urban space of the city, and the environmental quality has deteriorated compared to 10-20 years ago. Therefore, urban areas are facing many challenges related to natural disasters, climate change and the ecological integrity.

In order to achieve the set economic goal with sustainable development, the city's urban government has been trying to find its own solutions, but without interfering, affecting existing structures or approved master plans to relieve the pressure of the city on the impacts of natural disasters, climate change and environmental pollution. In this context, Nature-based Solutions becomes an effective intervention. The design of this solutions is to exploit and use the technical characteristics of plants, soil and other natural elements in the area to intervene, and then improve the existing solution or propose new ways to address emerging challenges.

On the process to integrate with international partner, in 2016, Quy Nhon city was one of the 25 partners in the world choosing to participate in the project "New strategy to regenerate nature for cities through innovative nature solutions". URBAN GreenUP" (under the European Community's Framework Program on Research and Innovation - Horizon 2020 funded by the European Community) to learn from the experiences of other cities participating in the project, applying Nature-based Solutions in Quy Nhon city area. The project has researched, developed solutions and proven that investing in "nature" in many forms is a viable solution that can effectively respond to the challenges that arise in the face of the constantly changing extreme impacts to develop Quy Nhon towards a "sustainable" city.

One of the deliverables of the project that the partners participate in is the development of the Renature Urban Plan of the participating city using Nature-based Solutions according to the methodology developed and tested by the project.

The Renature Urban Plan based on Nature-based Solutions of Quy Nhon city will analyse the common characteristics, uniformity and similarity in terms of natural geographical conditions (topography, climate, hydrology, ecological system etc.) and on socio-economic characteristics (production activities, urban development, industry, planning) of the city, then urban zoning and analysis of the problems and challenges of each city zone. On that basis, it is proposed a priority list of NBS that are suitable with natural characteristics, ensuring effective intervention of existing challenge and in line with priority development orientations of the master spatial planning in each approved zone.



5.1 Introduction

5.1.1 Quy Nhon city landscape and development

Quy Nhon in history

Quy Nhon city has its history dated back to the third king of Champa empire lasting 400 years, the city was the land of the old Champa culture. The city located at a strategic position, good for the defence and easy for the overall capture of the land with the surrounding high mountain and hill, while it is also convenient for the inland waterway transportation through Kone river and the Thi Nai lagoon. The city with its original name of Hoai Nhon land included Quy Nhon city and later in 1832 was officially named Quy Nhon land by Minh Mang king. The city keeps its name and develops based on the strategic advantage through commercial line through seas routes.



Figure 5.1: Overview of the city in 1932



Figure 5.2: Quy Nhon city in 1969

In 1898, king Thanh Thai established Quy Nhon town as one of the most vibrant commercial ports of the country. At the beginning of the 20th century, Quy Nhon city developed further toward the South and circling Thi Nai lagoon, expanding its technical infrastructure including different seaports and airports. Under the management of the French colonial empire, the city developed its distinct urban features and planning directions resemblance with many European cities at the same time with multipurpose infrastructure, sea-land linkages and the urban layout that keeps its architecture until the current day. The new government of Vietnam established the city officially in 1970 consisting of two districts namely Nhon Binh and Nhon Dinh and part of the vicinity of Phuoc Hau, Phuoc Hai and Phuoc Ly communes.

Current status of Quy Nhon city

Quy Nhon city was officially recognized as the level II city according to the Prime Minister decision No. 558/TTg on July 4 1998. After that, the city has gone through several revisions of its urban planning which reflect the growing and re-orientation of city's development directions to become an industrial, commercial, educational and tourism hub of the Central region of Vietnam. The city then expanded to the South-West (Phuoc My commune) and the North-East (Nhon Hoi economic zone) thus forming different functional zones with specific focus on industry, culture and commerce, technology and university, and the resident areas

(typically, Nhon Hoi will heavily focus on industry, the old quarter – French influenced corner is the cultural and commercial zone, and the new development area will be the technology and university zone).

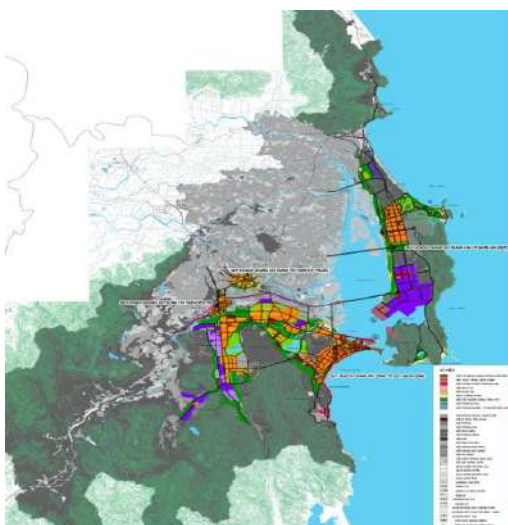


Figure 5.3: Urban planning for Quy Nhon in 2004

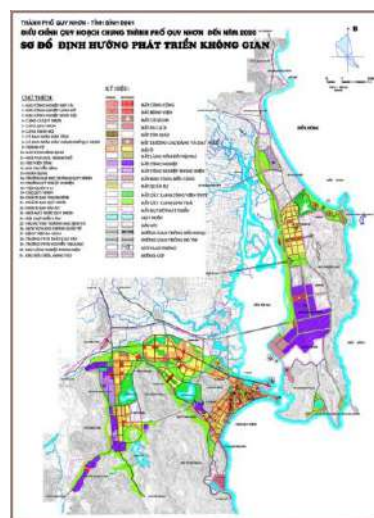


Figure 5.4: Revision of Quy Nhon urban planning towards 2020

Quy Nhon city as of 2010 was recognized as level I city³¹. Currently the city spreads over an area of 212,000 hectares with 454,400 inhabitants. Due to the different stages of planning and development of each area of the city, there are different dominant spatial planning and landscape direction to exploit the ocean front of the city whilst the old quarter of the city follows the hub-and-spoke pattern for the spatial planning of the road and infrastructure. The old quarter with its distinct architecture and spatial planning arrangement is the location of administrative buildings and public organizations (some of the landmarks for the city including Cu Lao Xanh lighthouse, Tran Hung Dao statue, Quy Nhon bishop building). The new urban areas recently developed include the new industry, service, tourism facility that spreads throughout the beach front. With the advantage of the beach and the surrounding nature, in recent years Quy Nhon is the tourism destination for millions of international and domestic tourists. The city has been honoured with the prize for clean tourism city (recognized for its green space for citizens and visitors) at the ASEAN Tourism Forum 2020 (Brunei).

³¹ According to the urban categories of Vietnam, urban areas are classified with different conditions (mainly based on the number of residents, the public space, housing unit, green space per capita and technical infrastructure) namely Special (metropolitan), level I, level II, and level III (as the lowest).



Figure 5.5: View of the current coastline of Quy Nhon city



Figure 5.6: Green space in the public park next to the shoreline highly valued for the landscape of the city

The city vision until 2050

The city planning and vision towards 2050 has been revised and approved by the Prime Minister of Vietnam government at the decision No. 495/QDD-TTg dated April 14, 2015. In the new revised city planning, the city area is planned to be at 67,788 hectares, the city is expanding towards the north-east direction to include other rural communes (Cat Tien, Cat Chanh and part of Cat Hai 3,847 hectares) in the south-west direction (Cat Vinh and Canh Hien communes, with the area of 13,676 hectares). The forecasted population of the city until 2035 is about 650,000 -680,000 inhabitants. The emphasis for the city until 2050 includes:

- The provincial's political, technological and cultural focal point.
- One of the sea links and coastal economic area of the region and nation with the sea related industry-tourism-service centre together with the research and education hub to support the development of the province and the South Central and Highland area.
- One of the connection hubs, serving the strategic defence and development of the region

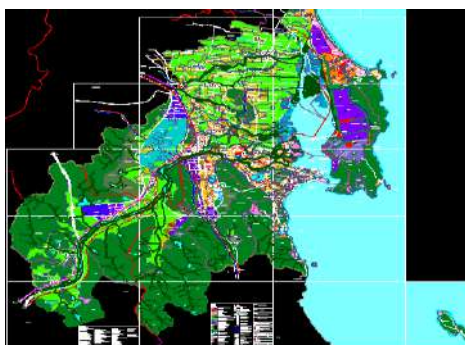


Figure 5.7: The revised urban planning of Quy Nhon and its vicinity to 2035 and vision to 2050

The main drivers for the development of the city is on the strategic connection hub and the rich ecosystem of the Thi Nai lagoon (on the north east of the city) and the coastline where most of the green space is developed, and economic activities are based and supported. The spaces that create the main economic driving force for Quy Nhon are Quy Nhon port, Nhon Hoi economic zone, eco-tourism urban areas, commercial centres, hotels and resorts, etc. and are all based on the advantages of the shoreline. Through each historical period of development,

the city's urban green space has changed in terms of space to serve socio-economic development. Recently, a number of new and old urban cities and transport infrastructures have been formed, which have affected existing mangrove and sand dune ecosystems, leading to urban green spaces becoming more vulnerable to the impact of urban development that limiting the natural disasters and climate change adaptation capacities. Therefore, the city government has put more effort in recovering and forming many new green spaces for the city to adapt to the above impacts.



Figure 5.8: The mangrove wetland ecosystem and the sand dune topographical landscape of Phung Mai peninsula part of the city is under pressure from urban development

5.1.2 The natural conditions, landscape and ecosystem

5.1.2.1 The natural conditions, landscape and ecosystem

Quy Nhon city is a large coastal city in central Vietnam and the economic, political, cultural, scientific, technical and tourism centre of Binh Dinh province. The city has Thi Nai lagoon to the Northeast, the mountain surrounding to the Southwest, in addition the city is located at the lower basin of two large rivers of the province, Ha Thanh and Kone (these two river basins flow through the city before draining to Thi Nai lagoon before going to the sea).

The city has a steep and complex topography, with the main slope direction from West to East, mountains and plains alternating. The city's landscape is diverse, including hills, flatlands, rice fields, ponds, lakes, rivers, seas, peninsulas and islands, contributing to the formation of magnificent landscapes with a coastline of over 42 km and Thi Nai lagoon. The landscape can be divided into 4 different terrain types including: High and steep terrain (mainly in the Northwest and West region); hilly areas in the midland (mainly in the South and the West region); plains (concentrated in the West and South) and coastal shoreline. The rich landscape of the city thus limits the development of urban space in the city, forcing it to disperse in each habitable sub-region. The city has a rich large brackish ecosystem in Thi Nai lagoon running more than 10 km long, nearly 4 km wide, located in the northeast of the city. The lagoon is a valuable resource of the city serving both the natural resources needed and the environmental regulation for the adjacent urban area that is the highlight of the coastal city Quy Nhon compared to other urban areas; is considered as the "green lung" of the city with an area of about 10 hectares of mangrove (for Quy Nhon city area only), which plays the role of regulating the microclimate and "shielding" natural disasters; Thi Nai lagoon also has many

attractive eco-tourism sites (Con Chim eco-tourism area; residential area of fishing village along the lagoon; ...) and is a place that brings high economic benefits in aquaculture, fishing, and seafood. However, this is also a vulnerable area due to the urbanization process of the city in recent years.



Figure 5.9: Quy Nhon city topography



Figure 5.10: The division of the river basin where Quy Nhon city is inside (red circle).

The city landscape has many existing green spaces such as natural green spaces and trees on Ba Hoa mountain, on the parking system (the residential land accounts for 3.8% of the total land) and many scattered spaces along the road system. In addition to the green space, the water surface of the city is very large such as the river system, lakes inside city (Dong Da ecological lake, Bau Sen lake, Phu Hoa lake), and the Thi Nai Lagoon. Those water surface not only maintains the natural landscape but also contribute to regulating climate change and mitigating the urban flood risk.



Figure 5.11: Mangrove forest “green lung” of the city



Figure 5.12: Hình. Dong Da ecological lake

The city's climate has two distinct seasons (dry season and rainy season), dominated by the North-Eastern monsoon in the rainy season (from September to December) and the West-South monsoon in the dry season (from January to August). The average annual temperature is about 26.6°C, The highest temperature months are the same with drought months June, July, August; The coldest month is January. Rainfall in the rainy season accounts for 80% of the annual rainfall; The rainy often coincides with the storm season. The average annual rainfall ranges from 1,600 - 1,700 mm/year, the rainfall is concentrated in 4 months (September -

December) causing waterlogging and flooding in many areas. The climatic condition of the city together with its topographical landscape contribute to the formation of a variety of ecosystems such as secondary forest ecosystems, agriculture, freshwater bodies, lagoons, coral reefs, which support the typical population settlements, urban areas, and industrial parks of Quy Nhon city.

5.1.2.2 Social economic characteristic

The city is organized into 16 city urban wards and 5 rural communes with a total population of 289,296 people. The urban population of Quy Nhon city in 2018 was 264,124 people, accounting for 91.30% of the total population; rural communities has 25,172 people, accounting for 8.71% of the total population. In the city, the population is unevenly distributed among wards and communes. The population density in central urban areas (old quarter) is 3,457 people/km², 20 times higher than in rural areas, of which Tran Hung Dao ward has the highest population density of 19,946 people/km²; The all 5 rural communes have population densities of less than 1,000 people/km² (Figure 5.13 and Figure 5.14 shows the distribution of urban and rural communities and the growth of the total population of the city).

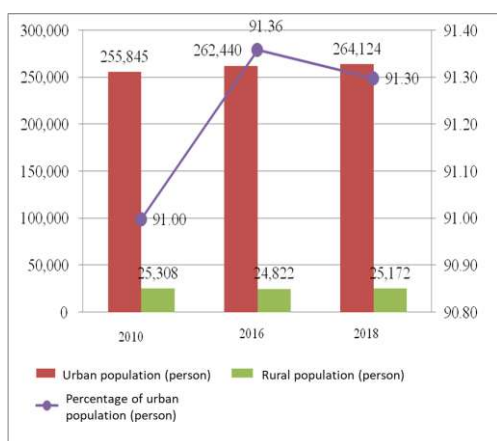


Figure 5.13: The structure of Quy Nhon population over the years

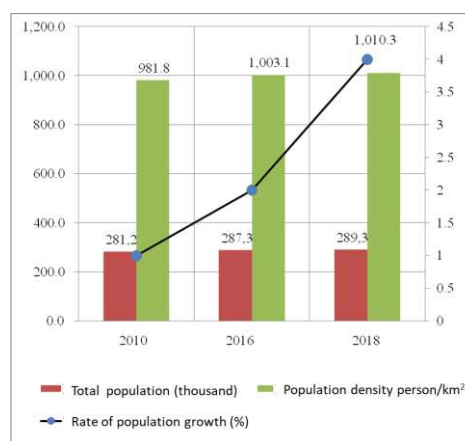


Figure 5.14: Population growth of Quy Nhon over the years

The city has four common modes of transportation including road, rail, air and sea. In particular, sea transport to Quy Nhon port is an important factor that plays a role in promoting the city's socio-economic development. In recent years, the city's economy has been continuously developing with a high economic growth rate; As of November 2018, the total production value reached VND 61,011 billion, an increase of 11.7% compared to 2017. In particular, the city's economic structure has had a strong shift in the proportion of industries – services sector, gradually reducing the proportion of agriculture; industry and construction 12.1% - services 11.5% - agriculture, forestry and fishery 4.7%. Thus, the city's economic development strategy has been less dependent on agricultural production, which has negatively impacted on natural ecosystem and the environment.

In the city, there are 2,113 industrial production establishments doing business in industrial parks and economic zones such as Nhon Hoi economic zone; Phu Tai Industrial Park, Long My;

Quang Trung, Nhon Binh and Bui Thi Xuan industrial clusters; Fishery logistics service area on island 1A north of Ha Thanh river; ... has industrial production value of 41,547.6 billion VND, attracts 76,570 employees with main products such as: refined wood, shoes leather, medicine, granite, mechanical products, etc.

Thus, it can be seen that the urban green space of Quy Nhon city is more vulnerable to the impact of its natural geographical location, socio-economic development and the impact of natural disasters and climate change. In the future, urban green space will be more seriously under pressured with the city government strives to achieve its economic development goals and the city's population increases by about 600,000 - 620,000 people (2025) and continues to increase by about 650,000 – 680,000 people (2035).

5.1.3 Summaries on the spatial planning of Quy Nhon city

According to the general planning of the city in 2004 and adjusted in 2015, besides the existing economic driving force of the two main centres, Quy Nhon central area and Nhon Hoi economic zone, the urban space of Quy Nhon city is continuing developing to the northeast and southwest of the city to create new economic development centres. At the same time, the goal of the city in the future is to be **"the political, administrative, economic, cultural and scientific and technical centre of Binh Dinh province; one of the nation's marine economic centres, the centre of industry, tourism, trade - services, shipping services, healthcare, education and training, research and application of the South Central Coast, and Central Highlands"**; also shows that the city is an important driving force for socio-economic development for Binh Dinh province and other neighbouring areas. With the reality of urban space development and future socio-economic development goals, then it is necessary for the city to build more new urban spaces and invest in urban infrastructure systems to connect with the city current infrastructure. Connecting the old and new urban areas, means the city will face many related challenges. In addition, the city's goal in the future is to **"build a brand of Quy Nhon coastal urban area, attracting tourists with the rich natural landscape, strong emphasis on historical and cultural identity; high-quality living, learning and investment environments"**, showing that the city considers "green space" development a part of the city's socio-economic development in the future.

In the revised urban planning for Quy Nhon, there has been some new directions on the designing of the urban infrastructure and environment for the main economic development areas so that it will meet the sustainable development goals and improve the connectivity of the city's infrastructure. Some main directions include:

- Coastal area – mainly support the development of multipurpose structures serving the development of tourism.
- The new development area of the northeast and southwest of the city, the new development structure should integrate the current landscape, forming green corridor connecting the highland and the river system.



- The rural area, transform to the urban agriculture model, maintaining current agri-forestry-fishery ecosystem, and applying high-tech agriculture.
- For flood vulnerable rural areas, it is required to exploit ecotourism services and aquaculture farms. Building in the direction of green urban areas, increasing drainage capacity on river tributaries in the area. Forming urban areas with landscape architecture in accordance with the natural settings. Other rural areas on high elevation located in the southwest of the city are building rural farm economic models.
- For hilly areas: Planting and regenerating forests, restoring indigenous trees with good vitality and ability to adapt to climate change; protect forests, conserve nature and biodiversity, improve the efficiency of tropical rain-forest protection to reduce natural disasters, prevent erosion, and conserve water resources.
- For the area along Thi Nai lagoon, continue to develop the eco-tourism landscape, conserve the ecosystem; develop agro-ecological tourism and craft villages in association with conservation and promotion of cultural values and historical relics. Create a green corridor separating Thi Nai lagoon with Nhon Hoi economic zone, restore mangrove forests associated with aquaculture development.
- For the existing parks in the city centre, it is required to develop it into green parks. Upgrading the system of coastal parks. Construction of theme parks to serve the needs of entertainment and tourism. Build ecological parks along river tributaries and arrange green areas, flower gardens in urban areas.
- For water drainage and flood prevention: Construction of flood protection dikes and mangrove planting; reclamation and dredging of river beds; and encourage the construction of permanent houses with concrete floors higher than flood level to cope with flooding situation.



5.2 The city's current challenges existing NBS and its targets related to NBS implementation

5.2.1 The city's current challenges

The overall natural conditions and its development activities have many potential and explicit challenges in terms of rising temperature, increase and concentrated rainfall, drought and flooding due to the climatic condition and climate change impact. Along with that, the recent development of urban socio-economic infrastructure and industrial activities of the city have contributed to the increasing economic outputs, improving living conditions for urban citizens. However, the increasing in industrial activities and the supporting infrastructure of the industrial zone comes with many environmental and ecological challenges that the city is trying to solve. Some of the main and dominant challenges are the variability and changing of the climatic conditions, the urban heat island, the urban flooding, air and water pollution.

a. Increasing temperature, drought and heat island

The average annual temperature in Quy Nhon city in the period 1961 - 2019 is 26.6°C, higher than that of other coastal locations in Binh Dinh province. Monitoring results during this period show that the average annual temperature trend in Quy Nhon city is increasing.

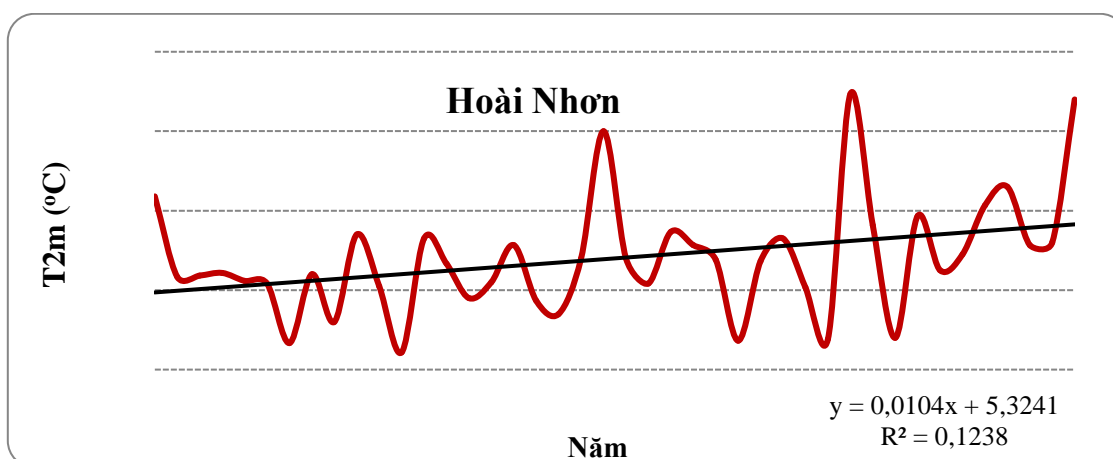


Figure 5.15: The linear increasing trend of annual average temperature measured at Quy Nhon (°C) period 1961 - 2019

During the period 1961 - 2019, the average temperature in all seasons at Quy Nhon station showed an increasing trend with an increase of 0.1°C/decade, all the maximum values of the average temperature of some months of the summer season in 1986, 1987, 1992, 1998, 2003, 2005 and 2016 exceeded the average temperature of the previous months for many years by 1-1.5°C and exceeded the average annual temperature by 3,2 – 4.7°C. Recently, heat and drought has taken place more seriously with unpredictable developments. Especially, in 2016, the survey results showed that there was 93 ha of rice land and seasonal vegetable land in Quy Nhon city lacking water.

The maximum and minimum annual temperature in the period 1961 -2019 show a weak increasing trend (Figure 5.16 and Figure 5.17), however according to the climate change

scenarios RCP4.5 and RCP8.5, at the end of the 21st century the estimated average annual temperature in Quy Nhon city will increase by 1.8°C and 3.3°C respectively. The predicted temperature shows a sharp increase in temperature during the day and summer in Quy Nhon city. The results of the climate change vulnerability assessment indicate that drought due to temperature increase will affect areas such as Nhon Hoi, Nhon Binh, Phuoc My, Nhon Phu, Tran Quang Dieu and Bui Thi Xuan.

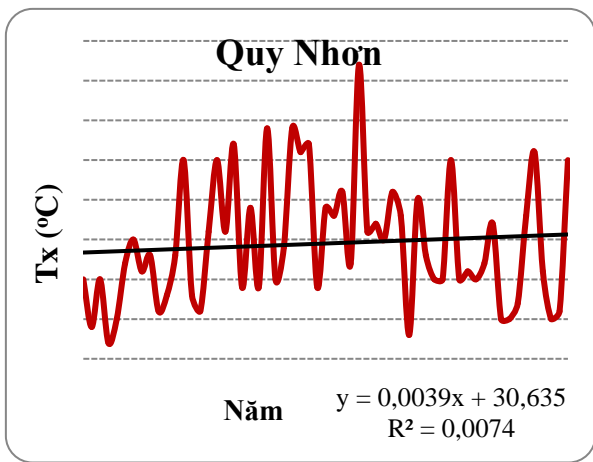


Figure 5.16: The increasing trend of the maximum temperature in Quy Nhon period 1961 - 2019

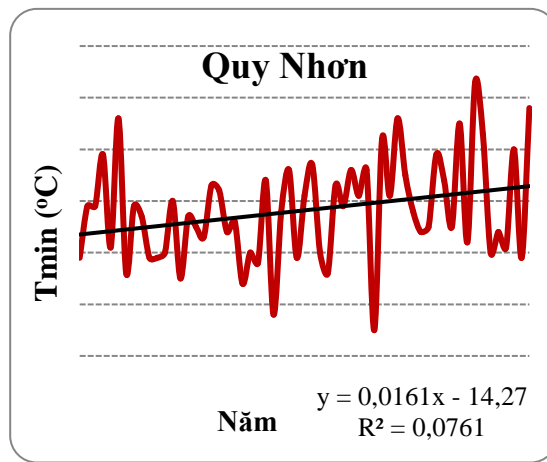


Figure 5.17: The increasing trend of minimum temperature period 1961 - 2019

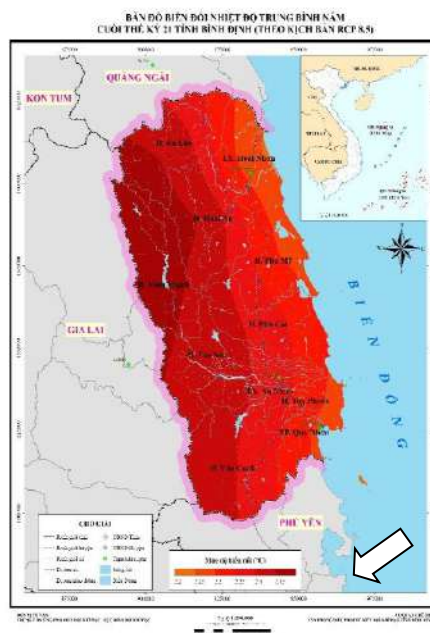
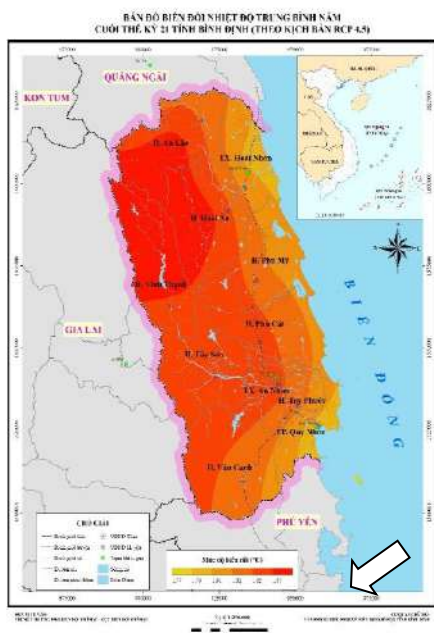


Figure 5.18: Temperature scenarios (annual average temperature) at Quy Nhon according to RCP4.5 (left) and RCP8.5 (right)

Thus, it can be seen that the increasing temperature factor is a big challenge that will negatively affect the drought and the ecological system of the city in the near future.

In recent years, the process of urbanization has taken place rapidly in areas of Quy Nhon city, urban population is increasing rapidly compared to rural population, at the same time the conversion of previously-green covered area for the development of transportation, housing and other facility for the social-economic development has led to the reduction of the green space. The reduction of the green space in the city together with the rising temperature in the vicinity area of Quy Nhon city has created many periods of maximum temperature peaks and raised the minimum temperature of the city in recent decades (significantly is the heat wave period of summer 2016).



Figure 5.19: Change in the green area (which is replaced by urban area, infrastructure, land use change) from 2009 - 2019 (Google Earth)

b. High rainfall and urban flooding

Rainfall in Quy Nhon city is not of that extreme compared to other regions of Vietnam in tropical zone, however, there have been indicators that the rainfall in Quy Nhon have an increasing trend (one day maximum rainfall and 5 day maximum rainfall). According to two climate change scenarios RCP4.5 and RCP8.5, the annual rainfall will increase by 20,8% and 17% while the total rainfall season (September to December) will increase by 16% and 20.3%. Increasing rainfall in combination with the increasing surface sealing of the city for infrastructure development in the recent year pose a higher challenge regarding the pluvial flooding.

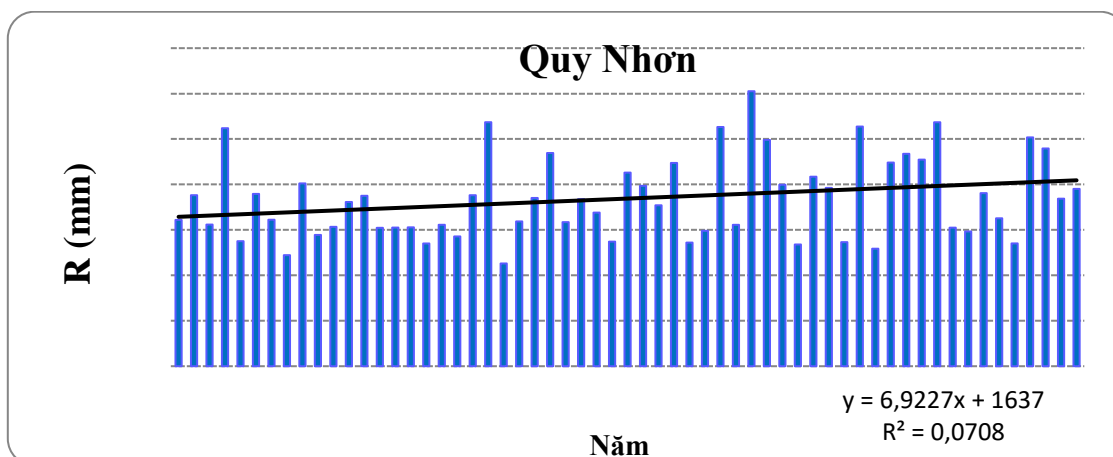


Figure 5.20: Annual rainfall trend at Quy Nhon period 1961 - 2019

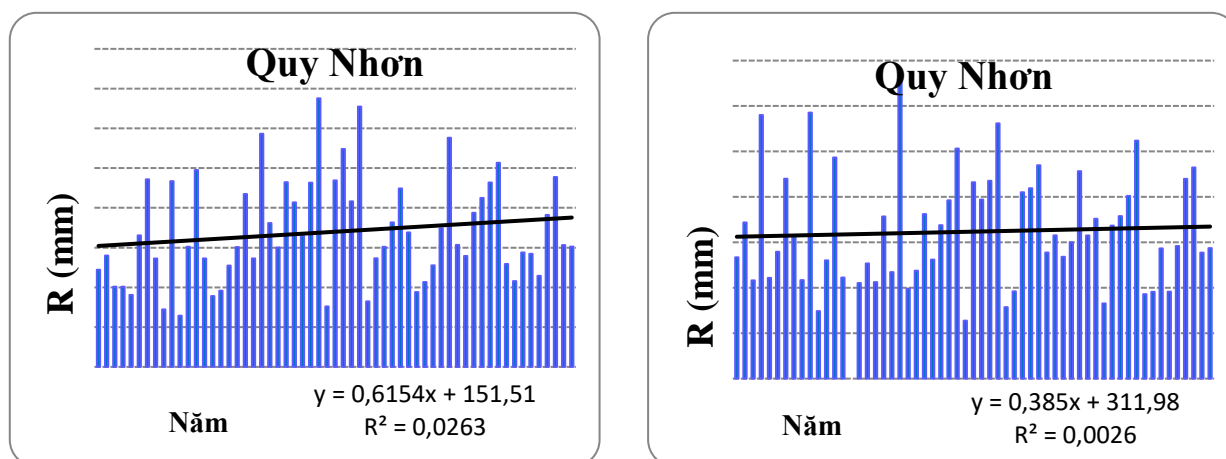


Figure 5.21: One day and five day maximum rainfall at Quy Nhon, period 1961 - 2019

In addition, Quy Nhon city is located downstream of two rivers Ha Thanh and Kone, part of the city is still under high pressure of flooding due to increasing water level from river system that can overflow and cause flooding during simultaneously heavy rainfall event upstream and at the city that overwhelm the drainage capacity of the city. The climate change adds further difficulties with the increasing average annual rainfall and in some years there has been a dramatically increase such as 1998 (total 3,026 mm), or 2009 (4,719 mm). In order to minimize flooding and increase the surface water area for runoff storage, the city has issued a guideline that not allows any levelling and filling up of surface water area that cause the shrinking of the natural lakes and drainage system. However, there needs to be more solutions regarding the green infrastructure for the city to cope with the urban flooding and managing the water in the city in the context of climate change.

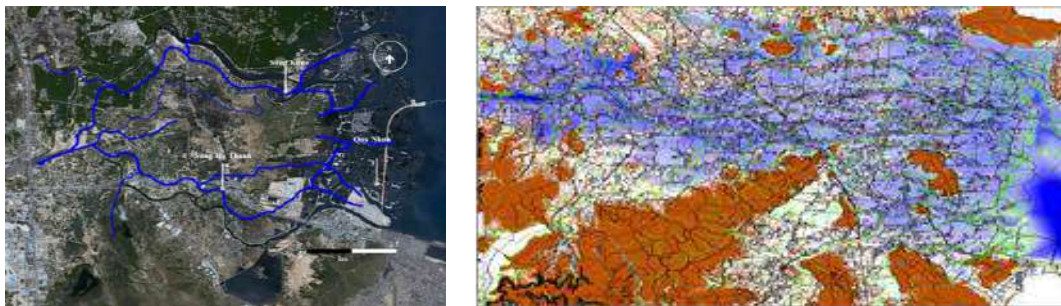


Figure 5.22: River system around Quy Nhon city and the flood map of Quy Nhon

One typical flooding event that affect seriously the social economic activities of the city happening on the area next to Ha Thanh river on December 3, 2009, the flood water level at Dieu Tri bridge reached 730 cm, the maximum flood flow reached 3,330 m³/s, the peak flow of flood was 6.8m³/s/km² several times higher than the flow of a typical year, bringing great loss of life and property to the people of Quy Nhon city.

c. *Natural disaster and monsoon storms*

Due to the geographical features and natural topography of the coastal city, combine with the impact climate change Quy Nhon often faces many natural disasters, especially storms, directly affecting the technical infrastructure and environment, including the existing green infrastructure of the city. From 1990 to now, the city has been impacted by an average of 1.0-2.0 storms per year. Storms mostly arrive during the monsoon season from September to November. In recent years, the trend of storms has changed, the time of storms occurring has been extended possibly from May to December. According to statistics, the number of storms in the period 1951 - 2015 occurred in months (May: 01; June: 02; August: 01; September: 04; October: 17; November: 16; December: 02). Usually storms occur, accompanied by heavy rains causing flooding and damaging the green infrastructure including trees, canopies, urban green parks), the rebuilding period for the city and the green infrastructure also takes very long to complete. For example, storm No. 5 (Hurricane Matmo) took place at 5 pm on October 30, 2019 directly affecting the city areas for about 10 hours, causing damage with a total value of over 24 billion VND, mostly infrastructure such as roads sea embankment works.

As a consequence, in the past time, the city government besides using a lot of green space and water surface, most of them have built many "hard" construction works using reinforced concrete to make river and sea embankments to cope with natural disaster. Therefore, another challenge that needs to be addressed by Nature-based Solution includes the capability of the NBS to sustain and overcome the impact of stormy season and support the greening and the general environmental quality of the city.



Figure 5.23: The damage caused by Hurricane Matmo (2019)



Figure 5.24: The flooding of the road system in 2020

d. Air and noise pollution

According to the regular monitoring of air quality in Quy Nhon city, the data shows that the city is currently facing challenges in controlling the air quality and the emission of air pollutants from construction, transportation, industry and residential activities in the period from 2016-2020.

In the urban residential areas, air quality is affected by 02 main pollution indicators, namely dust (TSP) and noise, the highest monitoring results occur at urban intersections, in which the highest recorded observed pollution value occurred in the years 2017, 2018, 2019. The monitoring locations in residential area are showed in Figure 5.25. All of the monitoring locations have the total suspended particles (TSP) parameters higher than the national standard for ambient air quality (from 1.86 to 1.93 times higher than the standard). In combination with the TSP parameters, the vibration and noise pollution are also higher than standard (from 76.5dBA to 78.5dBA higher than the standard parameter for residential area 1.13 times). It is attributed to the high traffic density due to vehicles moving on the main routes connecting urban areas including service to the construction projects in Nhon Hoi economic zone (Phuong Mai peninsula). The city council has implemented the planting of trees in the street intersection for limiting air pollution as well as expanding the traffic network but the situation is not getting better, the air quality monitored in recent years does not show any sign of decreasing.



Figure 5.25: Air quality monitoring locations

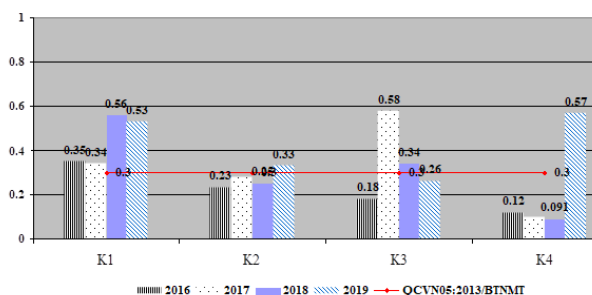


Figure 5.26: TSP concentration measured in the residential areas (QCVN: 0.3 mg/m³)

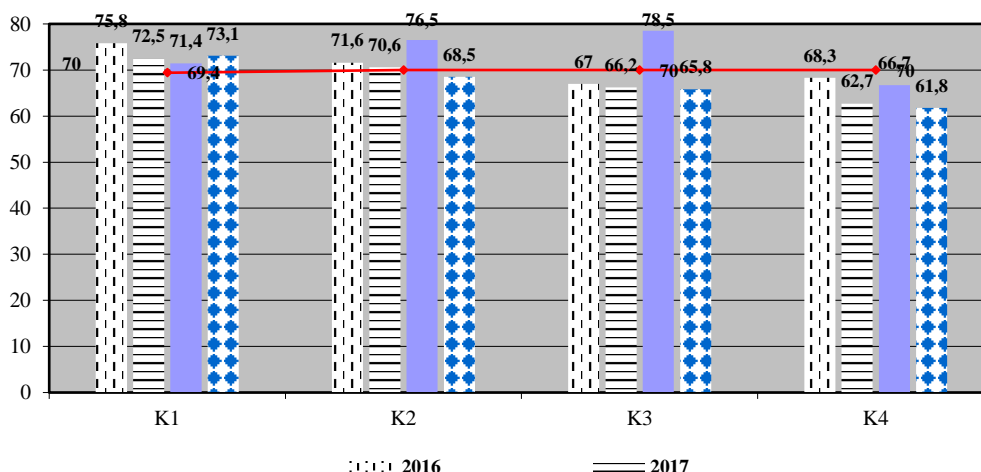


Figure 5.27: Monitored noise parameter (dBA) in residential area

The air pollution (TSP parameter) measured in the industrial area show that the level of TSP is in the range of the national standard (except for certain years and specific for one location only). It means that the TSP in the industrial area has been in good control for the industrial process. In addition, because most of the TSP for Quy Nhon urban area has traffic origin, inside the industrial area the low traffic compared to residential area can explain the reduction in the TSP level. Four industrial air quality monitoring stations are Nhon Hoi industrial zone (K5), Phu Tai industrial zone (K6), Long My industrial zone (K7), and Nhon Binh industrial cluster (K8).



Figure 5.28: Air quality monitoring locations in the industrial areas of Quy Nhon city

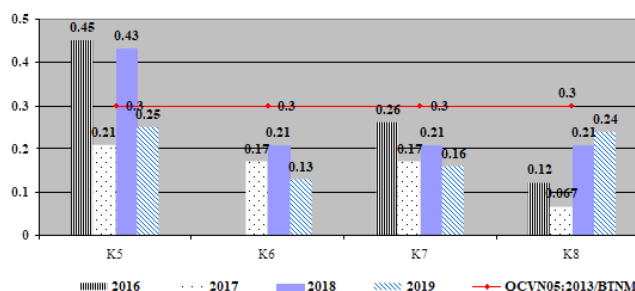


Figure 5.29: TSP concentration measured in the industrial areas (QCVN: 0.3 mg/m³)

e. Water pollution at river and lake of Quy Nhon

Currently, surface water bodies area is under great pressure from waste sources from daily activities of urban residents and industrial activities. In the period 2016 - 2019, the value of surface water quality pollution in the dry season in rivers, lakes and lagoons is usually higher than in the rainy season, mainly organic pollution, which is shown through O2 main indicators BOD₅, COD. The monitoring location are on the river (M1), on the urban lake (M2) and the Thi Nai lagoon (M3). Results show BOD₅ parameter is higher than the permit standard water quality suitable for irrigation, transportation or similar purposes QCVN08-MT:2015/BTNMT. Especially, the results also show that the level of water pollution at location close to residential area is higher than the measured value at other locations, which show that the effect of the

runoff discharge from residential areas negatively affect the water quality of the water body in those areas.



Figure 5.30: Water quality monitoring locations

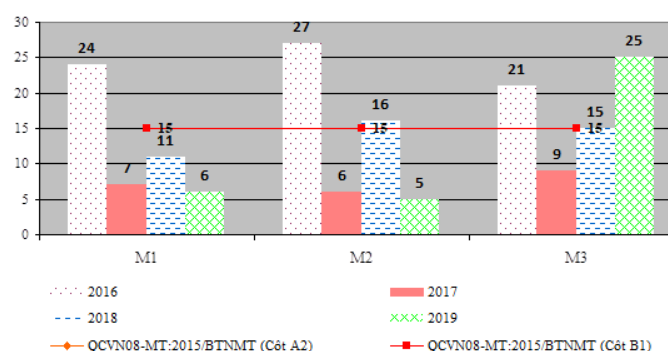


Figure 5.31: Measured BOD₅ in the water body on Ha Thanh river and Thi Nai lagoon

5.2.2 City’s existing and activities towards NBS application

In the past time, urban trees in the city have been planted and are well managed contributing to the improvement of street landscape, mitigating air and sound pollution at the same time that reduces urban heat island impacts. Urban tree planting is a part of urban regeneration solutions that local authorities and city people have been implementing. Trees in urban areas are planted in a scattered and concentrated form with many different plant varieties. On January 16, 2020, Quy Nhon city received the ASEAN Clean Tourism Award 2020, which includes the criterion of "high green spaces".



Figure 5.32: Part of the green space in Quy Nhon city and Quy Nhon is honored with Clean Tourism Award 2020

Recognizing the importance of the mangrove forest on Thi Nai lagoon as one of the aquatic wetland ecosystems for the protection of the city against storms and strong waves, the city has gathered all the support from international donors and its own effort to develop and maintain the mangrove areas of the Thi Nai lagoon. Through projects aiming at improving the ecosystem services of Quy Nhon city by the development of the mangrove forest, there are currently more than 10 hectares of mangrove reforestation in the lagoon funded through various organizations such as Rockefeller foundation, USAid, CRS and project on protection and development of mangrove forest in Binh Dinh province.



Figure 5.33: The development of mangrove forest at Thi Nai lagoon 2012 and 2019

Following the national campaign on the planting of one billion new trees in Vietnam, led by the Prime Minister, Quy Nhon has follow through with its own campaign to plant new variety of urban trees in old and new urban area in the period 2021 - 2025. The tree planting area includes bare land and the sand dune area where there has been a strong sand movement and sandstorm on the Phuong Mai peninsula. The city has encouraged the development of tourism facilities which include the green ecosystem and tree planting to stabilizing the sand dune area that can serve both the social economic development and the green infrastructure on the bare land.



Figure 5.34: Green landscape development with tourism activities on Phuong Mai peninsula



Figure 5.35: Planting new tree in the one billion trees national campaign

With the direction of greening the city to promote the landscape and harmonizing the development with the nature, Quy Nhon city has invested, converted and restored some of its degraded lakes towards a green space and ecological lakes. Dong Da lake is used to be a shipyard, docking place and the dumping sites for residential discharge that seriously pollutes the water. The design of the new lake has included several elements of NBS to increase the water infiltration and biofiltration using the floating ecosystem. In 2015, the lake renovation design won the 2A Asia Architecture Award in Istanbul, Turkey and the Star Sea Architecture Award in the Central - Central Highlands region.



Figure 5.36: View of Dong Da lake after the renovation

With the growing impact of solid waste and plastic waste to the integrity of ecosystem and aquatic life, the city has implemented various activities on solid waste collection, treatment, and recycling for the greening of the city. Those campaigns such as Plan to implement the movement "Against plastic waste" (2018); Action plan for ocean plastic waste management (2020); Directive on Strengthening the management, reuse, recycling, treatment and reduction of plastic waste (2020) have been integrated in the overall plan of the city on the renaturing of the city, cleaning up the landscape with different solutions and the adoption of environmentally friendly materials. The city has achieved major milestones with solid waste and plastic reduction through investment in the infrastructure of waste collection, treatment and greening the landfill area. Every year, the city promotes at least two campaigns to cleaning up the beaches, the street and maintaining the public green spaces.



Figure 5.37: Campaign on cleaning up the beaches (2019)

Figure 5.38: Public artwork on solid waste and plastic waste collection on Quy Nhon beach (2020)

5.2.3 The city's NBS implementation targets and stakeholders

Policies, strategies and plans for management and development of green spaces and NBS of the city:

At the national level: Urban planning law (2009); Land law (2013); Construction law (2020); The circular on review, revise and approve the urban planning (2010); Circular on the management of the architecture and urban landscape (2010); Construction standard – urban planning (2008);

At the provincial level: Adjustment of the general planning of the city and its vicinity towards 2035, with a vision to 2050 (2015); Regulation on management of urban planning and

architecture (2018); Zoning plan of 1/2000 scale of 12 inner city wards and cities (2020); Regulations on types of trees to be planted on the sidewalks of streets in Quy Nhon city (2019); ... in addition, in some specific topographical areas, the city government prepares 1/2000 construction planning and construction planning 1/500 for construction management such as areas near Thi Nai lagoon, lakes, hills, etc.

In addition, local green space management is also integrated into related policies, strategies and plans such as environment, climate change, transportation, energy, construction, etc. Related policy and strategy documents are : Planning on afforestation and protection of mangroves (2010); Air quality control (2021); Transportation Planning (2015); Green Growth Action Plan (2017); Biodiversity Conservation Planning (2017); Plan for the implementation of the Paris agreement on climate change (2019); Action plan for ocean plastic waste management (2020); Action plan to respond to climate change (2020); Implementation plan of the Program of Planting a Billion New Trees (2021); Renewable energy development planning; Planning for development of building materials (2017).

Stakeholders and their roles in the green space and NBS related management at Quy Nhon city:

The agency directly advising the Provincial People's Committee in terms of state management for the city's green space is the Department of Construction, Department of Agriculture and Rural Development. Depending on the type of green space, it will be decentralized to different organization, for example green space including water surface space of ponds, aquaculture lagoons and natural forests will be managed by the Department of Agriculture and Rural Development; green space which is inside the coastal and sea surface will be managed by the Department of Natural Resources and Environment; Department of Construction manages green spaces and trees in urban areas. The agencies and units that directly manage the maintenance and utilization of urban trees in accordance with regulations include: Quy Nhon urban green park and lighting joint stock company; Quy Nhon city public service management board; People's Committees of wards, communes and urban management offices.

City's relevant targets concerning greening of the city and NBS:

According to the city's recent green growth development plan in combination with different actions plans on climate change mitigation, biodiversity conservation and pollution control, the following relevant targets on greening the city and application of NBS are presented:

- By 2021 - 2025, the city government set a target of 352 ha of new trees area planted, each year approximately 50.4 ha in urban areas in the form of dispersed urban tree and 20 ha of protection forests in the form concentrated forest or urban forest.
- With the precipitation runoff: Limiting all the occurrence of inner urban area inundation, and reduction of time and area of flooding area of the outskirts area; increasing the coverage of the drainage system to 90% of the urban development area.
- Require a minimum of 20% of the new development area reserved for green space; the development in the hilly, coastal and lagoon area have to guarantee no impact to the natural topography of the area.



- For the space surrounding lake and river system a strip of 15 -30m with different forms of NBS and green infrastructure must be organized serving the community.
- The organization of space between construction works must ensure the distance according to regulations, take advantage of wind direction and visibility between layers of works to ensure the promotion of landscape values;
- For wastewater drainage: build and complete a centralized and decentralized wastewater collection and treatment system in suburban areas using environmentally friendly technology; Increase the percentage of households connected to wastewater collection system to 90%; Reuse from 20% - 30% of wastewater for irrigation, road washing and other needs.
- For apartment buildings, the green space requirement is 1m²/person: encourage the organization of lawns, flower gardens, lakes, miniatures, garden trees, and trees along the fence.
- For commercial-service-residential mixed works: Encourage the organization of lawns, flower gardens, lakes, miniatures, decorative green trees in the garden, trees along the fence, on the terrace of commercial works.
- Up to 80% of production and business establishments meet environmental standards, of which 50% of the facilities apply clean and environmentally friendly technologies.



5.3 Objectives and scope of the Renature Urban Plan for Quy Nhon

5.3.1 Objective

i. Overall objective

The Renature Urban Plan (RUP) for Quy Nhon City is developed as a complementary urban NBS application plan to best support the approved urban spatial planning by increasing the use of Nature-based Solutions to address challenges arising in the process of development, maintain essential functions and services of natural ecosystems, and ensure sustainable development of natural and socio-economic systems that meet the targets of the city council and in line with the best practices of NBS on the world.

ii. Specific objective

- Reviewing existing natural solutions to propose new NBS applications in accordance with approved urban spatial planning and the existing infrastructure.
- Development of zoning for the application of NBS for the specific purposes and needs of each zone according to the city's targets and planning.
- Proposing the adoption of NBS and prioritizing the application of certain NBS for the specific planning and development of each zone.
- Specifying the role and responsibility of the organization responsible for the overseeing RUP implementation.

5.3.2 Scope of this RUP

- The scope of RUP implementation is the existing Quy Nhon urban area with an area of 28,553 ha, including 16 urban wards and 5 rural communes (excluding neighbouring localities of Quy Nhon city).
- Time to implement RUP: to 2035, with a vision to 2050 (according to the timeline of Revision of Quy Nhon City Master Plan in Decision No. 495/QD-TTg dated April 14, 2015).



| | | |
|--------|---|--|
| Step 1 | City characterization as regard to NBS implementation | Reviewing natural, social-economic characteristics of Quy Nhon. Consultation and analysis |
| Step 2 | City zoning for the renaturing of urban plan purpose | Zoning method, based on DPSIR, spatial master plan, and ecosystem services characterization Consultation and analysis |
| Step 3 | Appropriate NBS selection | NBS catalogues and analysis of its benefits, relevant application from URBAN GreenUP Consultation and analysis |
| Step 4 | Organization of the NBS implementation in the RUP plan | Legal status, responsibility, mission statement, consultation. |

Figure 5.39: Steps implemented in the development of Quy Nhon renaturing urban plan

5.3.3 Zoning of Quy Nhon urban area for RUP implementation

With the URBAN GreenUP project methodology on Nature-based Solutions suitable for different challenges, for effective and sustainable urban regeneration, the RUP is considering several factors for the application of NBS in Quy Nhon. It will be based on the existing NBS that has been successfully implemented at Quy Nhon, based on the common characteristics in terms of natural geographical conditions (topography, climate, hydrology, ecosystems) and on socio-economic characteristics (production activities, urban development, industry, planning) of the city, in which the most dominant natural factors approach to urban regeneration zoning are planning factors and ecological system.



Figure 5.40: Zonning of Quy Nhon city for the RUP plan and the application of NBS

The detailed zoning description for RUP is as following:

- **Zone 1 (N1): Inner city of Quy Nhon**

This zoning includes 11 urban wards including: Thi Nai, Hai Cang, Le Hong Phong, Tran Hung Dao, Le Loi, Ly Thuong Kiet, Ngo May, Tran Phu, Nguyen Van Cu, Quang Trung and Ghenh Rang.

- **Zone 2 (N2): Ha Thanh river and Thi Nai lagoon**

This zoning includes 6 wards and communes: 5 urban wards (Bui Thi Xuan, Tran Quang Dieu, Nhon Binh, Nhon Phu, Dong Da) and 1 rural commune (Phuoc My).

- **Zone 3 (N3): Nhon Hoi economic zone.**

This zoning includes 3 rural communes: Nhon Ly, Nhon Hoi, Nhon Hai.



5.4 NBS selection for RUP

In this chapter, the selection of suitable NBSs based on the analysis of opportunities to be applied in each urban zone from the NBS catalogue (NBSC) of the URBAN GreenUP project to intervene with the challenges arising from Quy Nhon city is shown. Details of the characteristics of each zone's challenges will be match with suitable intervention using NBS. Among the characteristics analysed, the planning orientation of each zone is an important guidance to the selection of the appropriate NBS.

5.4.1 Characteristics and the challenges of each zone

a. Zone 1 (N1): Inner city of Quy Nhon

- **Scope:** Natural area of 52.32 km², total population 161,100 people.
- **Characteristics and functions:**
 - The centre of politics, administration, economy, culture and science and technology of Binh Dinh province.
 - The multi-functional mixed-use urban area with educational, medical, defense, agency and commercial and tourist service establishments.
 - Areas with landscape of mountains, lakes, coastal areas, cultural works.
 - An area with green parks to serve the needs of entertainment, sightseeing and well-being of the citizens and visitors.
 - The focal point of technical infrastructure, the transportation hub of the province (road, railway, waterway).
- **Current situation**
- + Zone N1 has a spatial development structure according to the hub and spoke figure, main urban axes run in the East - West direction associated with coastal space, with high population density.
- + The administrative agencies, cultural, commercial and entertainment centres of the province and the city are mostly located in this zone, built along the Quy Nhon coastal route and built along the streets according to the grid network.
- + The housing areas are divided into each street block with the characteristics of a traditional commercial street associated with busy commercial activities. The structure of the housing is in the form of 3-5 floors, with a small shop, and an area of about 70-120m²/household. The architectural appearance here has not yet followed distinctive nuances, there are no clear spaces for community activities, culture and tourism to create an impressive image and attractiveness for Quy Nhon city in the future.
- + The sidewalk space is very narrow, not well managed, and the quality of urban space in many places is still low.



- + Types of green trees such as street trees, garden-park trees, waterside trees and urban green areas basically focusing on new development with suitable functionality integration.
- **Related challenges**
- + Zone N1 is the centre of development of the city with high population density and construction, so it faces many environmental challenges (air, water and noise pollution as well as the well-being of citizens due to lack of space); rapid increase in the number of personal motor vehicles and construction activities increase air and noise pollution as well as contributing to the "urban heat island phenomenon".
- + Low ratio of the green space/person as well as the lack of green park is also due to the prolonged extreme heat and flooding caused by climate change natural condition of the city that contribute to the difficulty of maintaining and developing green trees in the zone.
- + In subdivision N1, the aquatic pollution at Bau Sen Lake, Phu Hoa Lake, Dong Da Lake, as shown by the high concentration of BOD₅, COD, Ammonium (NH₄⁺), Phosphate (PO₄³⁻) monitored.
- + High tide and big waves caused by storms that limits the drainage capacity of the city that can cause local flooding, in areas located directly adjacent to the sea such as Nguyen Van Cu, Ghenh Rang, Tran Phu and Hai Cang wards.
- **Spatial planning direction**
- + Develop and complete the park system, trees on roads, squares, open spaces, combine with the work on renovating monuments, flower gardens, and fountains.
- + Renovating, embellishing and developing new community living space, connecting urban open space.
- + To gradually implement a system of walking paths, especially in the central area, connecting cultural and public works with green corridor.
- + Renovating and embellishing the sidewalk system in combination with the addition of urban utilities such as urban trees, flower beds, seats, public trash cans, information boards, public toilets serving people and travellers; paying special attention to serving people with disabilities to access and use.
- b. Zone 2 (N2): Ha Thanh river and Thi Nai lagoon.**
- **Scope:** With total natural area of 162,78km², and total population of 108.644 people.
- **Characteristics and functions:**
 - As a new urban development area of the central city, combining renovation and embellishment in synergy with urban infrastructure.
 - As a new urban centre with facilities and amenities to serve the needs of urban areas and to meet the accommodation needs of workers in industrial parks and surrounding areas.



- As an area with regional public centres for training, health, physical training and sports; integrating lake landscape into urban landscape.
- As an area with green space connecting regional public centres with river and mountain landscapes in the area.
- As an area with ecological landscape tourism of Thi Nai lagoon, with a diverse and rich ecosystem.
- As an area with the urban agricultural character.
- As the gateway for flood water drainage of the city.
- As the focal point of technical infrastructure, the traffic hub of the city.

- **Current situation**

Zone N2 is adjacent to zone N1, which is a newly developed urban area of the city, including: Nhon Binh ward, Nhon Phu ward, Dong Da ward, spatial development morphology with characteristics of garden house architecture associated with the natural structure of the area along Thi Nai lagoon. Part of the zone develop along National Highway 1A with existing concentrated industrial and residential enterprises area.

The neighbourhoods in zone N2 are relatively spacious and modern, containing the main functions of residential, commercial and green area with a relatively high density. Some new urban areas are in the stage of investment and construction such as An Phu Thinh, Long Van Long My, which will bring a new face to Quy Nhon city in the future.

- **Related challenges**

- + Zone N2 has the nature and function of being a newly developed area to expand the population of the existing downtown area of the city with fast urban growth in recent years. In parallel, infrastructure construction activities (roads, civil construction works, etc.) are affecting the biodiversity in Thi Nai lagoon mangrove forest and river ecosystem.
- + This zone is the gateway to the inner city, so it is facing the challenge of air quality and noise pollution due to transportation
- + The zone has the overwhelm challenges of being strongly influenced by flooding from Ha Thanh river basin. The upper part of the Ha Thanh river is narrow and steep, so when there is a flood, the water concentrates quickly, the drainage capacity of the area is limited by the incompatible technical infrastructure and lack of natural infiltration due to the sealing of agricultural surface (including part of the mangrove forest) for urban development.
- + This zone is under great pressure from waste sources from daily-life activities of urban residents and industrial activities of the city, polluting surface water in the downstream of Ha Thanh River and along Thi Nai lagoon.

- **Spatial planning direction**



- + Areas next to riverside and lakeside landscapes require a public 15 m to 30 m serving the community, a maximum construction density of 5% (including architectural objects and walkways); No levelling, narrowing the flow of rivers and streams, shrinking of open surface areas; The construction along rivers and lakes encourage the construction of green fences, in case of building solid fences, it must have a minimum of 50% open space.
- + Renovate, embellish and upgrade the downstream branches of Ha Thanh river, combine with utilization of urban landscape to develop community activities.
- + Fully arrange public works, trees, flower gardens, playgrounds, residential parking lots (encouragement to build underground parking lots), and at the same time ensure the land area for provision of social services for urban society.
- + For the landscape area close to Thi Nai lagoon: Protect and prohibit the encroachment on water surface space, alter the shoreline, and deform the natural topography; Protect the environment and ecosystem of the lagoon, and at the same time promote the potentials of Thi Nai lagoon for the purpose of serving tourism development; Planting mangroves; Minimize the construction of works in the area adjacent to the water surface or on the water surface of Thi Nai lagoon.

c. Zone 3 (N3): Nhon Hoi economic zone.

- **Scope:** This zone includes 04 rural communes: Nhon Ly, Nhon Hoi, Nhon Hai, with total natural area of 67.64 km², total population 17,632 people.
- **Characteristics and functions:**
 - As the driving force for the development of Quy Nhon city, the surrounding area and the regional level.
 - As a high-class, modern tourist service area combine the advantages of sea, coast and island of Quy Nhon city.
 - As an area for clean and green industry, high-tech industrial park.
 - As a connection point for the air and associated logistics services.
 - As the focal point for road and waterway traffic of the province and the region.
- **Current situation**
 - + The N3 zone belongs to Phuong Mai peninsula, the East and South borders the East Sea, the West borders with Thi Nai lagoon, often affected by drought, storms, moving sand.
 - + This zone is a new development area, spatial development structure associated with National Highway 19B running to the sea and Thi Nai lagoon.
 - + Currently, the projects that are attracted and invest in the area are commercial complex, industrial parks and tourist areas, all of which are eco-friendly and environmentally friendly; a small part are residential houses.



- + In this zone, most of the trees are casuarina trees, blocking the moving sand. Planting and maintaining trees in this zone is carried out regularly.
- **Related challenges**
- + Subdivision N3 is located on Phuong Mai peninsula with sand dunes formed and existed for a long time. Recently, this zone has become a symbol of the city's industrialization with the formation of industrial parks, economic zones, coastal tax-free zones, seaports, etc. Construction activities on the sand dunes have removed the covering shrubs and grass leading to the destabilizing lower layer that increases the sand movement in the dry season where the weather is hot, dry and windy. Sand moving affects a lot to the infrastructure and the operation of machinery and economic activities.



Figure 5.41: Sand moving in the Nhon Hoi economic zone

- + Increasing temperatures and prolonged drought conditions coupling with strong winds can increase the risk of sand moving in this area. Therefore, the biggest challenge for the city is to increase and maintain green space in this area such as planting trees to withstand dry condition and sand moving.
- + Zone N3 is adjacent to coastal coral reef ecosystem, seagrass beds are quite rich ecosystem that need conservation. The increase human activities and discharge of pollution causes harm to the environment and the fragile ecosystem. Thus, different solutions need to be implemented to prevent the impact from land-use activities to that ecosystem.
- + Coastal erosion often occurs when there are storms, making sea level rise stronger, affecting people's houses and investment coastal tourism projects.
- **Spatial planning direction**
- + The development projects in the N3 zone must ensure ecological and environmental friendliness.

- + Principles of project construction must preserve and protect nature condition, increase green areas, maintain biodiversity and improve water quality.

5.4.2 Summary

Assessing the natural geographical conditions (topography, climate, hydrology, ecosystem) and socio-economic characteristics of the Quy Nhon area as a whole and the specific zones in which there are main factors that affect the NBS planning are ecological consideration, urban development and spatial planning (beside other such as the aesthetic, the economic, the indigenous, etc...). There are 3 zones of Quy Nhon city for urban regeneration based on natural solutions: Zone 1 (N1) - Inner city of Quy Nhon; Zone 2 (N2) - Ha Thanh river and Thi Nai lagoon; Zone 3 (N3) - Nhon Hoi economic zone. In each zone, the natural characteristics, functions, current status, challenges and planning orientation were studied and analysed. All of the above characteristics are the basis for selecting the right NBS to address challenges in each zone. The spatial planning orientations in each subdivision are the basis for proposing the location and type of NBS implementation.



| Zone | Current challenges | Potential NBS application | Potential benefit of applying NBS | NBS application position |
|--|--|--|--|---|
| Inner city of Quy Nhon (N1) | Air and noise pollution; urban heat island | NBS N1.1 include: <ul style="list-style-type: none"> - Urban carbon sink - Smart soil - Green facade - Hydroponic green facade - Vertical moving green wall - Green filter area - Urban garden bio-filter - Green roof - Green noise barrier | <ul style="list-style-type: none"> - Improve air quality - Improve microclimate - Water management - Erosion control - Water filter and wastewater treatment - Aesthetic improvement | <ul style="list-style-type: none"> - Intersection of Dong Da street. - The residential area at Ba Hoa, and Vung Chua. - The median strip on main streets. - Green parks. - Public administration and commercial buildings. |
| | Water pollution | N1.2 include: Floating garden | <ul style="list-style-type: none"> - Improve water quality. - Water filter and wastewater treatment - Aesthetic improvement - Entertainment and tourism | At Bau Sen, Phu Hoa, Dong Da lake. |
| | Storm | NBS N1.3 Urban forest and orchard | Mitigating effect of storm | <ul style="list-style-type: none"> - In green park and public square - Area close to mountain. |
| Ha Thanh river and Thi Nai lagoon (N2) | Air and noise pollution; urban heat island | NBS N2.1 <ul style="list-style-type: none"> - Urban carbon sink - Smart soil - Green facade - Hydroponic green facade | <ul style="list-style-type: none"> - Improve air quality - Improve microclimate - Water management - Water filter and wastewater treatment | <ul style="list-style-type: none"> - Ong Tho intersection - The median strip on main streets. - Green parks. - Public administration and commercial buildings. |



| | | | | |
|--|-------------------------------------|--|--|---|
| | | <ul style="list-style-type: none"> - Vertical moving green wall - Green filter area - Urban garden bio-filter - Green roof - Green noise barrier | <ul style="list-style-type: none"> - Aesthetic improvement | <ul style="list-style-type: none"> - Mountain area |
| | Water pollution on river and lagoon | <p>NBS N2.2 Natural wastewater treatment</p> | <ul style="list-style-type: none"> - Improve water quality. - Water filter and wastewater treatment - Aesthetic improvement - Entertainment and tourism | <ul style="list-style-type: none"> - Surface water on Ha Thanh river and Thi Nai lagoon |
| | Urban flooding | <p>NBS N2.3</p> <ul style="list-style-type: none"> - Floodable park - Carbon sink - SUDs - Urban catchment forestry - Parklets - Cycle-pedestrian green pavement - Pollinators verges and spaces | <ul style="list-style-type: none"> - Improve air quality - Improve microclimate - Water management - Aesthetic improvement - Improve flood drainage | <ul style="list-style-type: none"> - Bare land area of the unused space. - Pedestrian routes in the new urban development area. - Park in the new urban development area. - In the Ha Thanh river flowing through city, Thi Nai lagoon. |
| | River bank erosion | <p>NBS N2.4</p> <ul style="list-style-type: none"> - Chanel re-naturalization - Green resting area - Mangrove reforestation | <ul style="list-style-type: none"> - Erosion control | <ul style="list-style-type: none"> - Embankment areas from Ha Thanh river to Thi Nai lagoon |
| | Ecosystem | <p>NBS N2.5</p> | <ul style="list-style-type: none"> - ecosystem restoration | <ul style="list-style-type: none"> - Thi Nai lagoon |



| | | | | |
|-----------------------------|-------------------|---|---|--|
| | degradation | Mangrove reforestation | | |
| | Storm | NBS N2.6 Planting and maintaining green trees | Mitigating effect of storm | Park area, surrounding areas of lake and aquaculture areas |
| Nhon Hoi economic zone (N3) | Moving sand | NBS N3.1 Restoring casuarina on sand | | <ul style="list-style-type: none"> - On the designate green space of new development area - On sand dune. - Next to traffic road. - In the median strip on main street |
| | Coastal erosion | NBS N3.2 <ul style="list-style-type: none"> - Green resting areas - Planting and maintaining green trees | Erosion control | Park area of public area close to coastline |
| | Storm | NBS N3.3 Planting and maintaining green trees | Mitigating effect of storm | Park area |
| | Urban heat island | NBS N3.4 <ul style="list-style-type: none"> - Cool pavement - Pollinators verges and spaces - Pollinator green roof - Green fences - Rain garden | <ul style="list-style-type: none"> - Improve air quality - Improve microclimate - Water management - Aesthetic improvement - Improve biodiversity - Entertainment and eco-tourism | <ul style="list-style-type: none"> - In the ecotourism area - In the median strip on main street |

Table 5.1: Description of the three proposed zones for NBS implementation





Figure 5.42: Selected NBS applied in zone N1

Zone N1: Inner city of Quy Nhon**1. NBS N1.1**

- Urban carbon sink
- Smart soil
- Green facade
- Hydroponic green facade
- Vertical moving green wall
- Green filter area
- Urban garden bio-filter
- Green roof
- Green noise barrier

2. NBS N1.2

- Floating garden

3. NBS N1.3

- Urban forest and orchard.



Figure 5.43: Selected NBS applied in zone N2

Zone N2: Ha Thanh river and Thi Nai lagoon**1. NBS N2.1**

- Urban carbon sink
- Smart soil
- Green facade
- Hydroponic green facade
- Vertical moving green wall
- Green filter area
- Urban garden bio-filter
- Green roof
- Green noise barrier

2. NBS N2.2: Natural wastewater treatment**3. NBS N2.3:**

- Floodable park
- Carbon sink
- SUDs
- Urban catchment forestry
- Parklets
- Cycle-pedestrian green pavement
- Pollinators verges and spaces

4. NBS N2.4

- Chanel re-naturalization
- Green resting area
- Mangrove reforestation

5. NBS N2.5: Mangrove reforestation**6. NBS N2.6: Planting and maintaining green trees**

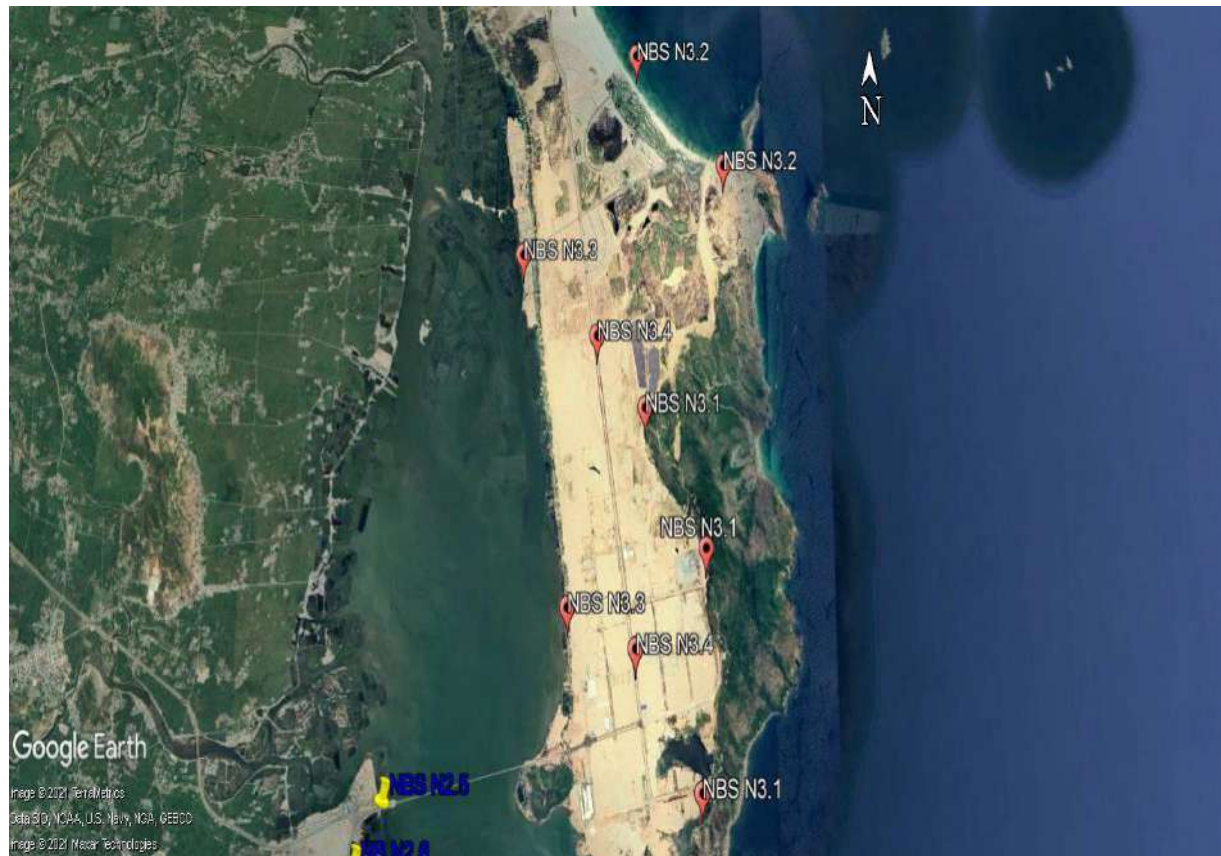


Figure 5.44: Selected NBS applied in zone N3

Zone N3: Nhon Hoi economic zone**1. NBS N3.1**

Restoring casuarina on sand

2. NBS N3.2

- Green resting areas
- Planting and maintaining green trees

3. NBS N3.3

Planting and maintaining green trees

4. NBS N3.4

- Cool pavement
- Pollinators verges and spaces
- Pollinator green roof
- Green fences
- Rain garden

5.5 The RUP implementation role and responsibility

5.5.1 Implementation principle

The implementation of the Quy Nhon Renature Urban Plan based on implementation of NBS complies with the decentralization of responsibilities according to the provisions of law and the approved master planning and other relevant specialized planning of each zone.

5.5.2 Role and responsibility of each party

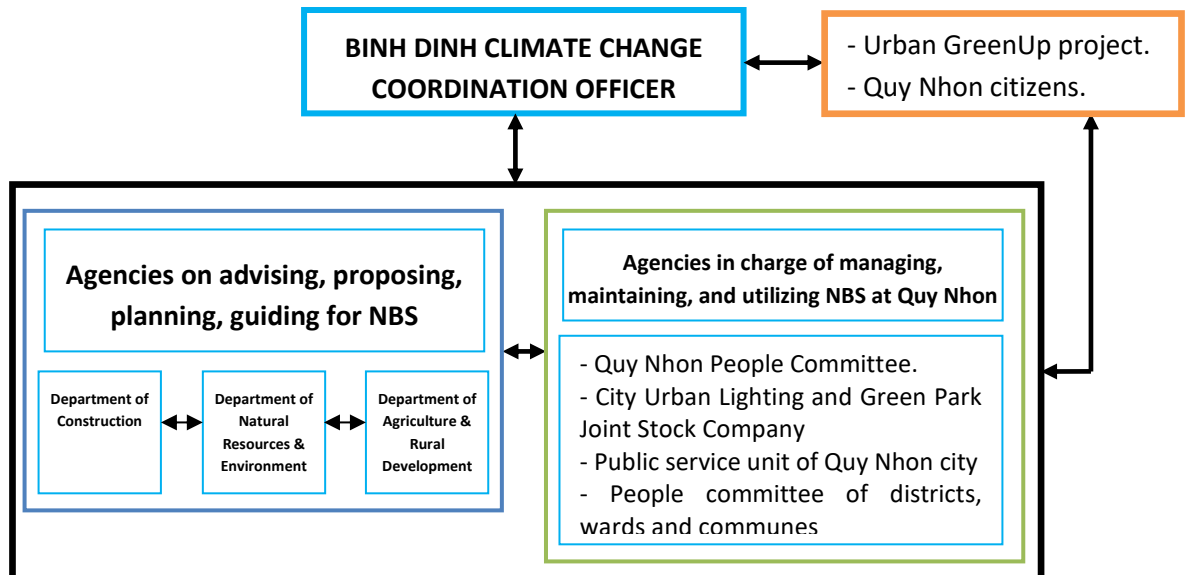


Figure 5.45: Summary of the arrangement between agencies related to NBS at Quy Nhon city

Binh Dinh Climate Change Coordination Office

- As the standing agency of the RUP, assumes the prime responsibility and actively coordinate closely with the Departments, branches, People's Committee of Quy Nhon city and related units and throughout the process of organizing the implementation of the plan.
- Having expert judgement and reviewing authority according to regulations.
- Coordinating with departments, agencies, People's Committee of Quy Nhon city and related units in the implementation of training, technology transfer training to implement NBS.
- Presiding over, monitoring, evaluating and reporting on the results of the implementation of the Plan.

Department of construction

- Having expert judgement and reviewing authority on investment proposals to implement Nature-based Solutions.
- Preside over the appraisal of technical reports, construction drawings for proposed NBS and advise the Provincial People's Committee for approval.

Department of finance

- Advise the Provincial People's Committee to arrange funding sources and guide the payment and settlement according to regulations.
- Preside over the appraisal of detailed cost estimates of proposed NBS and advise the Provincial People's Committee to approve the cost estimates.

Responsibilities of the local People's Committee and investors who receive the implemented NBS

- Prepare fully and promptly the necessary conditions of ground for proactive implementation.
- Organize communication in the media about the content, purpose and implementation time of the NBS.
- Responsible for implementation, operation and maintenance according to regulations.

The contractor's responsibilities comply with regulations on investment, solution management, according to the instructions of the state management agencies and according to the signed public work contract and contents.



5.6 Piloting NBS in Quy Nhon RUP

Based on the list of Nature-based Solutions (NBS) selected for each zone in chapter 4, in each zone a NBS pilot will be demonstrated in the renature urban plans to intervene in the current challenges.

The content of the proposed NBS pilot include the following parts: Purpose; Location; Content; Time; Expense; Implementation organization.

5.6.1 Piloting the green facades for Zone 1 – Inner city of Quy Nhon – N1

- Purpose: Reduction of air and noise pollution while mitigating the effect of urban heat island.
- Location: Urban public or private building along the main street.
- NBS description:



Figure 5.46: Green façade solution at the Dong Da intersection of Quy Nhon

A green façade is a wall that is completely or partially covered with greenery. The green façade with vines uses a hanging system to keep the vines rooted in the ground or containers.

This green façade can be grown in the ground or in a container and using a climbing and hanging system, they can be attached to any building or structure.

This green façade is built with: Land container (1); Soil mixture consisting of 30% sand, 30% compost and 40% topsoil (2); Mesh system (3); Vines (4); Clearance between the mesh system and the building (5).

- Estimated time of implementation: Depends on the nature of care and maintenance of the solution.
- Estimated cost of implementation: Depends on the size of the solution. Average €150 - 200 /m².

- Expected implementation unit: Depends on the scale of the solution. If the scale is small it will be an individual contractor; if the scale is large, the City Urban Lighting and Green Park Joint Stock Company is expected to implement.

5.6.2 Piloting the wastewater treatment – electrowetland at Ha Thanh river and Thi Nai lagoon Zone (N2)

Purpose: To facilitate the wastewater treatment, clean up the pollutant in water body of Ha Thanh river and Thi Nai area.

- Location: Surface water of Ha Thanh river and Thi Nai area.
- NBS description:

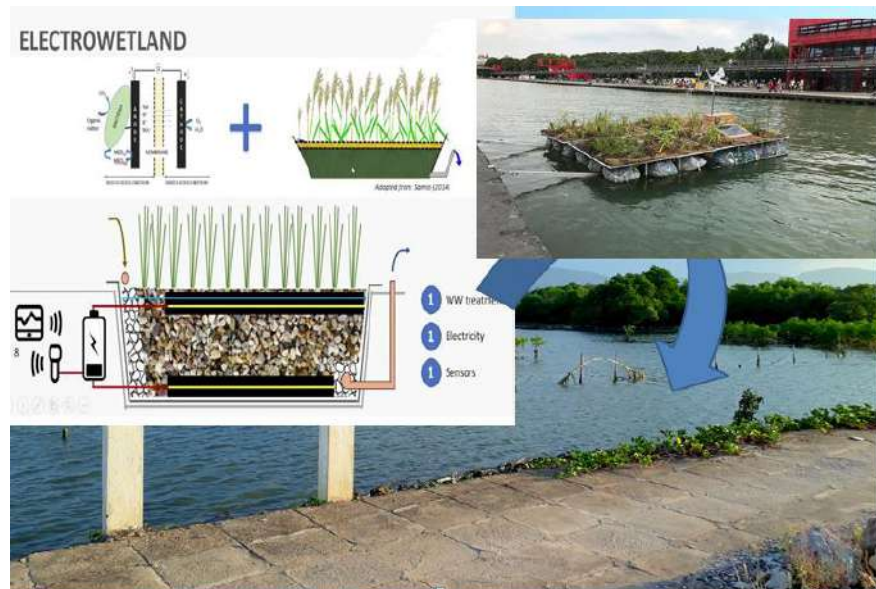


Figure 5.47: Electro wetland application at Ha Thanh river and Thi Nai area (N2)

Electrowetland solution is a natural wastewater treatment system that generates electricity from the oxidation of organic matter present in the wastewater. This solution is designed for permanent wetlands with electrodes inside.

This solution is made for surface flows or underground flows. In surface-flow marshes, or free-flowing wetlands, wastewater flows through the substrate while in subsurface marshes, or submerged aquifers, water flows underground through alternating gaps.

The solution acts as a complex ecosystem, made up of the following elements:

- + Treated water, flowing through the substrate and vegetation.
 - + Substrate, which is the support of plants and must retain microbial processes (in the form of biofilms), and is essential in most processes that aim to convert and transform water contaminants into biomass.
 - + Emerging aquatic plants provide surface area for bacterial membranes to form; They facilitate filtration and adsorption of wastewater pollutants, they help oxidize the substrate and remove nutrients, and control algae growth by limiting sun light penetration.
- Implementation time: 10-20 years.

- Estimated cost of implementation: Depend on the surface of the surface of the electrowetland and floating area. Average €150 - 200 /m².
- Expected implementation unit: Department of Natural Resources and Environment; City Urban Lighting and Green Park Joint Stock Company.

5.6.3 Piloting the raingarden in Nhon Hoi economic zone (N3)

- Purpose: To mitigate the urban heat island effect, increase the green space, improve runoff drainage, water and air quality.
- Location: In the median strip on the traffic route of Nhon Hoi economic zone.
- NBS description:
The Rain Garden solution is a shallow bio-enhanced water tank designed to collect, store, filter and treat runoff. Rain garden plants have to sustain with dry and wet conditions.
The designed rain garden solution includes: (1) A perforated pipe with an outlet that connects to a river or stream; (2) The inner pipe contains gravel material; (3) Natural land; (4) Soil mixture includes: 50% sand; 20-30% fertilizer and 20-30% topsoil; (5) Spill control design; (6) Vegetation. Native plants have deep root systems that absorb water and pollutants; (7) Sidewalks and gutters; (8) Surface water collection ditch of the road for surface water to overflow into the rain garden.



Figure 5.48: Rain garden on the median strip of Nhon Hoi economic zone traffic route

- Estimated time of implementation: 10-20 years.
- Estimate cost: Average €40 /m².
- Expected implementation unit: Department of Natural Resources and Environment; City Urban Lighting and Green Park Joint Stock Company; Nhon Hoi economic zone management board.

5.7 Management, implementation, revision and development of Quy Nhon RUP

5.7.1 Management and implementing RUP

As mentioned, RUP is a mandatory deliverable that each partner participating in the URBAN GreenUP project must submit to sponsors, including Binh Dinh partner.

After the submission of Quy Nhon RUP, based on the content that has been developed in the scope of the project, it is expected that the People's Committee of Binh Dinh province will make a decision to assign specific tasks to relevant departments, and agencies to implement and perform RUP.

The Climate Change Coordination Office of Binh Dinh Province has been assigned by the People's Committee of Binh Dinh Province to be the focal point for implementing the URBAN GreenUP project and also the agency in charge of developing the RUP. Therefore, the organization of implementation, inspection, monitoring and urging the implementation of RUP will be under the Climate Change Coordination Office of Binh Dinh Province.

Expected plan to implement RUP at Quy Nhon after submission:

- Content 1: Disseminate the plan to relevant departments, agencies and communities.
 - + Form of implementation: Websites of departments, and related agencies.
 - + Implementation time: 2021.
 - + Implementing agency: Binh Dinh Provincial Climate Change Coordination Office
- Content 2: Training human resources of relevant departments, agencies and communities on NBS technical content.
 - + Form of implementation: NBS technology transfer training.
 - + Implementation time: 2022.
 - + Participation: relevant departments, agencies, organizations, communities.
 - + Implementing agency: Binh Dinh Provincial Climate Change Coordination Office.
 - + Coordinating unit: It is expected that cities will deploy NBS demonstration; technical agencies implement NBS construction.
- Content 3: Pilot implementation of NBS in Quy Nhon urban zones
 - + Implementation mode: Pilot implementation of NBS in each zone.
 - + Implementation time: 2022 - 2025.
 - + Implementing agency: Binh Dinh Provincial Climate Change Coordination Office.
 - + Coordinating unit: relevant departments, agencies and communities

5.7.2 RUP updating and revision

Annually, the Climate Change Coordination Office of Binh Dinh province assumes the prime responsibility to coordinate with relevant departments, agencies, communities based on the actual situation in organizing the implementation data collection, analyse and evaluate the socio-economic development, impacts of natural disasters and climate change in each zone. From there, it is necessary to identify and forecast the challenges that may arise due to the



impacts and propose and select appropriate NBS to effectively intervene the arising challenges.

In the RUP, the NBS content specification and NBS deployment location for each subdivision need to be updated and revised to suit the actual challenges of impact and urban spatial planning.

5.7.3 RUP promotion

Quy Nhon intends to promote RUP according to O2 directions as following:

As mentioned above, the ultimate goal of RUP is to select suitable NBSs to effectively intervene in challenges arising from pressure from natural and socio-economic development impacts. Thus, it is found that being able to choose the right NBS depends a lot on the local socio-economic development strategies, master urban plans. Therefore, the direction of RUP development is the integration of RUP into local socio-economic development strategies, and master urban plans so that the most suitable NBS can be selected and effectively respond to the challenges that arise.

As described in the overview (chapter 1), in the future, Quy Nhon city has a forecasted economic growth rate to increase rapidly. This leads to negative pressures that will be much greater than the current reality on the surrounding environment and natural ecosystem, which requires the necessary resources (technological, economic, and skilled labor) to respond professionally to the new context. On the other hand, with the reality of Vietnam, including Binh Dinh province, NBS is a new technical solution that has not been researched and developed, therefore, the RUP can be developed in the direction of *investment, expand the development of professional services in consulting, design, construction and maintenance of NBS serving the public and private sectors.*



References

- URBAN GreenUP D1.1: NBS Catalogue 31.5.2018.
- Báo cáo hiện trạng môi trường tỉnh Bình Định giai đoạn 2010 - 2015, giai đoạn 2016 - 2020.
- Quyết định số 514/QĐ-TTg ngày 08/5/2019 của Thủ tướng Chính phủ về việc phê duyệt Điều chỉnh tổng thể quy hoạch xây dựng Khu Kinh tế Nhơn Hội, tỉnh Bình Định đến năm 2040.
- Quyết định số 05/2018/QĐ-UBND ngày 26/01/2018 của UBND tỉnh Bình Định về ban hành Quy chế quản lý quy hoạch, kiến trúc đô thị thành phố Quy Nhơn.
- Quyết định số 1674/QĐ-UBND ngày 06/5/2020 của UBND tỉnh Bình Định về việc phê duyệt đề án quy hoạch phân khu tỷ lệ 1/2000 cho 12 phường nội thành, thành phố Quy Nhơn.
- Quyết định số 495/QĐ-TTg ngày 14/4/2015 của Thủ tướng Chính phủ về việc phê duyệt Điều chỉnh Quy hoạch chung xây dựng thành phố Quy Nhơn và vùng phụ cận đến năm 2035, tầm nhìn đến năm 2050.
- Báo cáo Quy hoạch bảo tồn đa dạng sinh học tỉnh Bình Định đến năm 2025 và định hướng đến năm 2030.
- Quyết định số 2522/QĐ- UBND ngày 25/6/2020 của UBND tỉnh Bình Định về việc phê duyệt đề án quy hoạch phân khu tỷ lệ 1/2000 khu vực Đông đầm Thị Nại.
- Báo cáo Cập nhật Kế hoạch hành động ứng phó với biến đổi khí hậu tỉnh Bình Định giai đoạn 2016 – 2020, tầm nhìn 2030.
- Báo cáo Đánh giá tính dễ bị tổn thương do biến đổi khí hậu thành phố Quy Nhơn thực hiện năm 2011.
- Báo cáo đánh giá rủi ro sông Kone – Hà Thanh thực hiện năm 2019.
- Báo cáo tình hình kinh tế - xã hội, quốc phòng - an ninh của thành phố Quy Nhơn năm 2016, 2017, 2018, 2019.
- Niên giám thống kê thành phố Quy Nhơn năm 2016, 2017, 2018, 2019.
- Báo cáo Quy hoạch chi tiết Tiêu úng, thoát lũ và đề điều vùng hạ lưu sông Hà Thanh.
- Báo cáo Đánh giá Khí hậu tỉnh Bình Định
- Các Văn bản thu thập thông tin của các sở, ban ngành và địa phương cung cấp thông tin xây dựng RUP.



6 Annexes

Annex 1: Evaluation of all regulatory instruments pertaining to NBS in Medellín

6.1.1 Regulations within the Mayor's Office of Medellín

- **Agreement 52 of 1994 (and Agreement 23 of 1995) - Planting of fruit trees and native Colombian ornamental and forest plants**

Objectives and object: Institutionalize the planting of fruit trees and ornamental and native Colombian forest species in the city of Medellín. Scope of application: "Green areas for public use in the city. Riverbanks, streams and canalizations. Green areas of the closed units ceded by the Municipality. Avenues and main roads of the city and its neighborhoods that are without crops or gardens"

Actors: Ministry of Public Works.

Mechanisms and instruments: Established a \$500/tree guideline for each person who planted a fruit tree. He will coordinate this incentive with JAC, educational institutions, communities. It was hoped that the parents of each child registered in the notary's office would assume the adoption of a fruit tree and it was intended to include a plaque on each tree planted with the name of the adopter's child (notarial procedure). During the first year, it allocated 20 million pesos by the Public Works Reserve for the execution of the program.

Observations and reflections: Creation of two incentives (one economic, one affective) to the planting of fruit trees and native species, as mechanisms to promote co-responsibility for their care and maintenance. Definition of specific fruit species. Modification (Agreement 23 of 1995) that promotes the planting of native Colombian species in addition to fruit trees. The need to manage trees that posed a risk of overturning was recognized. It seeks the accompaniment of NGOs and Universities to advise on the definition of suitable species. The need for subsequent regulation (maximum 3 months) of the Agreement was pointed out, an aspect that in the end seems not to have been realized.

- **Agreement 54 of 1996 - Stimulates the decoration of green areas in Medellín**

Objectives and purpose: Create the annual contest of ante-gardens and the annual contest of green areas, preservation of basins and cleaning and beautification of margins of ravines.

Actors: Secretariat of Public Works (Department of Landscaping and Arborization). Council. Civic mayor. Director of the Department of Landscaping and Arborization. Director Cabildo Verde. Director of the Department of Forestry Sciences of Unalmed. Mi Rio Institute. Botanical garden. NGO representative.

Mechanisms and instruments: Committee (regulation, jury). Prize of 100 million (neighborhood with better green areas) and 50 million (neighborhood better ante-gardens, better care and preservation of the basin, better cleaning and beautification of the margins of ravines). Prizes paid in kind (works for education, health, culture or improvement of the sector).



Observations and reflections: Public incentive to conserve green spaces. There is no known evaluation of its effectiveness or outcome reports. Years later (recently) a contest of ante-gardens was held but currently it is not convened (personal communication with officials Secretariat of the Environment).

- **Agreement 53 of 2003 - Amemos Mi Río**

Objectives and object: Ecological and recreational program "Amemos Mi Río", created in order to sensitize citizens in the understanding of the interdependence relationship of human life with its biophysical environment, through the care, beautification and recovery of the Medellín River and its surrounding areas". Scope and object of application: River and surrounding areas. Promotion of citizen appropriation. Research development. Pacts for the care of streams and planting of trees and plants.

Actors: Secretariat of the Environment, Citizen Culture, and Education.

Mechanisms and instruments: Corporate and social responsibility policy for the sanitation of the river and its streams. It provided a stimulus to organizations and citizens for events that have had greater call and citizen participation, and for contributions to the care and cleaning of the ravines and planting of trees in their basins. The prizes would consist of the realization of works that the winning communities required in their sector. Annual campaign on environmental culture and the importance of the River and the streams. Schedule of permanent, recreational, artistic, cultural and recreational activities in the River and its surroundings. Programs to link students from the official sector to the activities of the River. Semi-annual report on the pollutants of the Medellín River and proposals, agreements and achievements for their reduction.

Observations and reflections: Objectives of citizen awareness and co-responsibility in the care of the river and its tributary streams. Promotion of transparency in relation to responsibilities for pollution (and sanitation) of the river. Participation of secretariats other than environment. Its follow-up and impact is ignored. Absence of EPM as a co-responsible actor.

- **Agreement 41 of 2005 - Medellín garden city of America**

Objectives and object: Create the program "Medellín garden city of America", whose general objective is to position Medellín as a city of flowers. Scope of application: parks and roads.

Actors: Secretariats of Environment, Planning, Public Works, Citizen Culture, Education, Social Development.

Mechanisms and instruments: Search for sponsorship of green areas by public or private actors, through agreements (6 months from the issuance of the Agreement for its regulation).

Observations and reflections: Objective of increasing green spaces and improving environmental quality and social welfare in the city, coupling it with economic and tourism development objectives. Specific integrative objectives of different dimensions of development. Absence of effective instruments and resources for its implementation. It is unknown whether there was specific regulation, results report and effectiveness evaluation.

- **Decree 1803 of 2006 - Urban Forestry Manual - Urban Forestry and Landscaping Committee**



Objective and objects: Adopt the Urban Forestry Manual and creates the Urban Forestry and Landscaping Committee (includes 4 functions). It establishes regulations for public works projects, public space and green areas, as well as the necessary institutional coordination for the implementation of the manual and the operation of the Committee.

Actors: Secretariat of the Environment, Administrative Department of Planning (Subdirectorate of Territorial Planning), Secretariat of Public Works, Various Companies of Medellín, Department of Communications of the Municipality, Metropolitan Area of the Aburrá Valley, Botanical Garden of Medellín, Public Companies of Medellín.

Mechanisms and instruments: Forestry Committee, as an advisory body that guarantees unity of opinion and coordinated, timely and efficient participation by the different instances that assume responsibilities and competence in the matter within the Administration.

Observations and reflections:

- Recognition of: assets and functions of urban trees, multiple actors intervening, multiple values and multi-sectoral criteria for urban green planning, need for technical guidelines that guarantee sustainability in the different interventions that are executed on urban flora, need for unity of criteria in the intervention, importance of the private sector, need to establish a land bank for the generation of green spaces.
- Questions: Should the framework of the Committee's competences be updated, in the light of changes in the administrative organization of the Municipality? Has the composition of the Committee changed? Should it do so, in accordance with the necessary limitations and adjustments? Does the Committee have an internal regulation? Has prepared a written balance of its performance in these 13 years, as well as recommendations (regulatory, technical, operational) for the Medellín Re-naturalization Plan?
- The Forestry Handbook is a key focus instrument for urban green planning. Is it desirable to further integrate the public space manual with the urban forestry manual, in order to increase its technical and political effectiveness?
- The Forestry Committee is a key body to ensure coherence between the guidelines given by the planning and management instruments and the way in which the works and interventions are carried out. It was desirable for the Committee to consolidate itself in terms of personnel or dedication, so that it could ensure the quality not only of the designs but of their materialization, and not only those of the public but also the private ones.
- The Forestry Committee is an essential actor in the structuring and formulation of a Re-naturalization Plan for Medellín, since it has key functions, for many years, in specific intervention projects on public space, which is presumed to have a learning and reflection on the essential challenges of the Plan and in general on the management of urban green.
 - **Decree 817 of 2008 - Policy on urban forestry and landscaping, Urban Forestry and Landscaping Committee**

Objectives and object: Adopt Policy Guidelines on Urban Forestry and Landscaping for the Municipality of Medellín (taken from the EPV Master Plan of the Metropolitan Area), with their respective purposes and strategies. It regulates the Committee on Urban Forestry and



Landscaping. Its purpose is the intra-institutional coordination for the intervention in public space, green areas, and public works projects.

Actors: SMA (leads). In addition to those established by Decree 1803 of 2006 is the Urban Development Company (EDU), as a permanent guest.

Mechanisms and instruments: Committee on Forestry and Landscaping. It mentions a Technical Data Sheet for the Evaluation of the projects that are analyzed in the Committee.

Observations and reflections:

- Recitals and resolves with few variations compared to Decree 1803 of 2006 (which repeals).
- The complements relate to the inclusion of definitions, the inclusion of new actors in the Forestry Committee, and the adoption of policy lines on urban green proposed by the Metropolitan Area.
- The same observations, reflections and questions that were included for Decree 1803 of 2006.
 - **Agreement 39 of 2008 - Integral intervention in slopes and edges for the environmental sustainability of Medellín with the creation of ecoparks**

Objectives and object: Develop the environmental public policy of integral intervention in slopes and edges for the environmental sustainability of the Municipality of Medellín in its rural and urban areas with the creation of ecoparks, involving environmental, educational, social, cultural, tourist and economic aspects. The initial scope of implementation is the edges and slopes of Communes 8, 3, and 1.

Actors: It doesn't point.

Mechanisms and instruments: None specific. It requires a cross-linking with the Territorial Planning Plan, the Environmental Management System (SIGAM) and the Environmental Policy of Medellín (PAM), and with the strategies defined in the 2008-2011 Development Plan.

Observations and reflections: It promotes a typology of intervention (and coparks) with environmental objectives and a defined general spatial scope, also involving educational, economic, social, cultural and tourist aspects. Limited and non-specific in its management and financing instruments. It would be necessary to investigate the implementation carried out (together with projects such as the Ring Road Garden, Green Belt, and others with similar objectives), the learnings obtained, and the expected scope in future projects to be developed in these areas of the city with high deficit of green public space.

- **Agreement 03 of 2009 - Environmental Tables in the Municipality of Medellín**

Objectives and purpose: Create and regulates the Environmental Tables and institutionalizes the Environmental Forums. Space for participation and environmental management.

Actors: Ministry of the Environment. Council of Medellín. Environmental Council of Medellín. Administrative Department of Planning. Secretary of Social Development

Mechanisms and instruments: Technical Secretary. Environmental forums. Environmental Participation Subsystem is articulated to the Local Planning and Participatory Budget, through



the Environmental Thematic Commission of the Communal and Corregimental Councils and the Zonal and Corregimental Environmental Tables, through the appointment of 2 members who will represent the Environmental Tables in the CAM (Environmental Council of Medellín).

Observations and reflections: Define the environmental tables and their objectives. Spaces of articulation at the zonal and corregimental level of the actors and sectors that make up the social and institutional system for environmental management and participation in Medellín, sustainable environmental human development at the urban and rural level, support and seek alternative solutions to problems and environmental damages of the territory from the local and to promote participation, reflection, debate, concertation, education and communication in environmental public management. They are instances of participatory environmental management in the zonal area and in each corregimiento, to mediate between the community and the State, seeking to contribute to the processes of planning, management, education, communication, concertation, levels of participation and control of environmental development, as well as in the direction of environmental public policies, strengthening, awareness and qualification of the interest of citizens in environmental issues. Fundamental instance for the governance processes within the framework of the strategy and the re-naturalization plan of Medellín. It is important to study its dynamics and functioning, as well as monitoring and evaluation reports, opportunities for improvement, and key roles in relation to the Re-naturalization Plan.

- **Agreement 77 of 2009 (regulated by Decree 874 of 2010) - Environmental Compendo in the Municipality of Medellín**

Objectives and object: Establish the “Environmental compendo” in the Municipality of Medellín. Scope of application: Sites for public use such as squares, parks, trails, stopovers, corners, traffic lights, telephone boxes, sewers or drains, hydrants, bus stops, zebras for pedestrian crossing, green areas, among others.

Actors: Taxpayers (natural or legal persons who incur in fault). Active subjects (Government Secretariat, Municipal Police Inspectors and Corregidores, Traffic Agents and National Police with traffic functions, Undersecretaries of Support for Justice and the Public Space Ombudsman's Office of the Municipality of Medellín). Health authorities. Companies Providing Public Cleaning Service.

Mechanisms and instruments: Compendo. Levels of sanction: Environmental education (4 hours) to the offender. Social service day. Fine between 2 -20 minimum wages. Sealing of real estate. Suspension or cancellation of license or registration. Arrest. Connection with National Police Code. Administrative Litigation Code. Resources obtained will be directed to education and environmental awareness campaigns. Indicators for monitoring the implementation of the environmental comparison policy. Control and surveillance committee to follow up on the implementation of the policy.

Observations and reflections: Agreement of interest in both the poor disposal and management of debris and waste (including burning) is a practice that threatens the quality and function of green public spaces. It points out 17 infractions subject to comparison, several of which have an impact on the quality and social and ecological functionality of green public space. Also, as a source of resources for environmental education in relation to the importance



of green public space. It is unknown whether this Agreement was regulated (it had a 2-month deadline for it), and whether it has outcome reports and impact assessments. Essential instrument for governance over green public space.

- **Agreement 35 of 2010 - Plant a Tree Save the Planet**

Objectives and object: Create the program Plant a Tree Save the Planet, aimed at primary and high school students of public educational institutions.

Actors: Secretariats of Education, Environment, Public Works.

Mechanisms and instruments: Schedule for each annuity, in which monthly, biweekly or weekly activities will be scheduled according to the case or the need of each school. Agreements with educational, university, technological, formal education institutions of the public and private sectors, Public Companies of Medellín, Metropolitan Area, Corantioquia, Various Companies of Medellín, in their ecological and social programs, to obtain the necessary resources for the fulfillment of the object of this Agreement. The Municipal Administration may acquire land with its own resources for the development of this Program or make agreements for the purchase of land.

Observations and reflections: Purpose of environmental awareness and citizen action for the planting and maintenance of plants. It is expected that each student at any time of primary or bacalaureate studies will plant a tree. It is unknown if this Agreement was regulated (it had a period of 3 months for it), and if it has impact evaluations. There are no specific references to the availability of planting sites or to the sources of financing for the acquisition of land.

- **Agreement 56 of 2010 - Schools in Medellín adopt a park and a ravine**

Objectives and purpose: The schools of Medellín adopt a park and a ravine. In order to strengthen environmental education from the new generations, educational establishments will develop activities aimed at the adoption of parks and streams in the area of influence of EIs. Scope of application: Educational institutions and parks and streams in their areas of influence.

Actors: Ministry of Education. Ministry of the Environment. Metropolitan Area.

Mechanisms and instruments: Guidelines given by Sec. of Education to educational institutions for the development of activities. Cooperation Programs. Conventions. Proposed activities: a. Cleaning and awareness campaigns with the community of the sector and neighbors of the ravines. b. Days of planting and maintenance of trees in the areas of withdrawals of the ravines. c. Accompaniment in the cleaning days scheduled by the Municipal Administration. d. Cultural activities, talks, courses and contests of painting, story, poetry, photography and videos among others. and. Massive campaigns on the importance of working together in the recovery of flora and fauna.

Observations and reflections: It do not define financial instruments for its implementation, beyond the usual nomination to seek cooperation agreements and agreements with public or private entities, and the indication of the need to reserve year after year resources from the regular budget of the *Secretarías* involved for the proposed activities. It proposed a regulation of the Agreement during the four months following its promulgation. It is unknown whether this was done, as well as the results and impact evaluations of the program.



- **Decree 920 of 2010 - The neighborhood oxygenates the city**

Objectives and object: Regulate Agreement 073 of 2009: Program "The neighborhood oxygenates the city". It promotes public policies aimed at the "recovery of air quality, landscaping and the formation of a good ecosystem in general terms; at the same time that it will make public spaces within each commune and in the neighborhoods used correctly oxygenating the city of Medellín". Areas of action: Tutelary hills, areas of removal of ravines, linear parks, neighborhood public spaces, educational campaigns and social appropriation.

Actors: Secretariat of Public Works (leads), Secretariat of the Environment, Secretariat of Planning, Secretariat of Citizen Culture, Public Companies of Medellín, Under secretariat of Environmental Culture.

Mechanisms and instruments: Opportunity lots. Inventory of green public spaces.

Observations and reflections:

- Establishes competences of SMA and Public Works in relation to the generation, recovery, restitution and maintenance of green public space. In creek retreats the SMA. In the rest, Public Works.
- Assigns to the Public Space Workshop Unit of the Administrative Department of Planning or the Under secretariat of the Environment, the responsibility of determining the opportunity lots, either for the establishment of the species to be compensated, or for the purchase of land for green areas and establishment of new tree species. It may also compensate these with payment in money to the Municipality of Medellín, so that it invests the resource for the same purpose, in the areas that are available for it, by the entities mentioned herein.
- It points out that anyone interested in carrying out any civil infrastructure work or urban action "that requires the elimination of green areas and tree cover, must compensate for them in area and quantity of species, in another site of the urban land or within the same project, if possible and for this purpose must avail themselves of the guidelines on compensation defined by the Environmental Authority".
- Mention of the project "The city greens its neighborhoods", which consists of improving the green and landscaped areas in the public spaces and green areas of the neighborhoods of the city, to rescue and highlight the landscape and environmental values existing in each intervened area and that includes landscaping works and not civil works.
- Review in the administrative organization of the Municipality if the operational division of Environment and Public Works remains in force.
- The Administrative Department of Planning will determine the possibility of occupation of the public green area with the construction of an equipment; for this case, it is established that the maximum occupancy rate with the construction of public equipment in a public green area or land ceded for green, recreational and equipment areas may not exceed 15% of the area of the property and in lots larger than 5,000 m² up to 20%. (Art 9). In green areas or public parks, intended for active and passive recreation, hard floors may be built in no more than 2% of the area of the lot (art 9). In protective soils, including withdrawals to water currents, births, strategic ecosystems, in principle, the construction of hard floors



will not be admitted. The green areas of public roads may become hard floors and have the planting of specific tree species, when the pedestrian flow is representative in the roads of high, medium or low hierarchy, and correspond to corridors of multiple zonal or neighbourhood activity or specialized, or are located within urban centralities or the traditional and representative centre, provided that they have not been established within the Special Plan of Heritage Protection, such as areas of urban preservation, biotic corridors to protect, complement or generate. The conversion of the vegetation cover to hard floor in ante-gardens, (private free frontal area belonging to the road-urban profile section) will only be admitted when they are part of Multiple Zonal or Neighbourhood Activity Corridors, and Specialized, Urban Centralities, and Traditional and Representative Centre, considering the requirements established in the Manual of Design and Construction of the Components of public space and the Manual of Urban Forestry that are in force.

- Administrative Department of Planning, Ministry of Finance and Environment, will keep updated the information corresponding to the public green areas generated by all the concepts that may be applicable, whether or not they are the product of the public transfer areas of the urban planning and construction projects or by direct purchase of the Municipal Administration destined to public use.
- The different competent entities, both public and private, must develop actions of social and educational accompaniment, tending to the conservation, appropriation of urban green public areas; these activities must be carried out before, during and after the respective physical intervention (Art 7).
- SMA and Sec Cultura Ciudadana will develop educational campaigns and different pedagogical strategies with social and community organizations established in urban land and community in general, for the care and conservation of public green areas.
- SMA will define the management for the production of tree species suitable and recommended for planting in green public spaces, with emphasis on native ones.

- **Agreement 31 of 2011 - The Ravines Recover their Natural Channel**

Objectives and object: Program "The Ravines Recover their Natural Channel". Scope of application: Quebradas and their retirement areas.

Actors: Ministry of the Environment (leader). Supports: Secretariats of Planning, Government, Health, Public Works, Isvimed, etc. EPM, Metropolitan Area, Various Companies of Medellín, Corantioquia.

Mechanisms and instruments: Annual programming of streams to intervene (from their source to their mouth). Monitoring and evaluation of the intervention. Census of settlements in retirement areas. Basic sanitation and other resources. Obligation to regulate the agreement in a maximum of 5 months.

Observations and reflections: It seeks to provide basic tools that allow a comprehensive treatment to the ravines of the city, in terms of sanitation, protection and readjustment of the banks, landscaping and linear parks, cleaning and maintenance, and if it is the case the relocation of the inhabitants of settlements and invasions with houses to these banks that do



not respect the withdrawals. Definition of prioritization criteria: protection of human life, stabilization of land. Definition of the need for monitoring and follow-up to the intervention (with adequate indicators), in charge of the "environmental entity", and the Ministry of Health (impact on morbidity, mortality, etc.). Area of utmost importance for the connectivity of the ecological structure of Medellín and as an area of offer of various ecosystem services. There is no known balance of the implementation of the program, its validity, and whether this Agreement was regulated.

- **Decree 2119 of 2011 - Restructuring of the Forestry and Landscaping Committee**

Objectives and purpose: Restructuring of the Committee on Forestry and Landscaping. Scope of operation: green public space and public works projects.

Actors: Ministry of Environment, Public Works, Territorial Planning. Corantioquia, National Police, AMVA. Botanical garden. EDU. EPM.

Mechanisms and instruments: Social and communicational data sheet. Technical concepts. Urban Tree System. Minutes and Action Plan of the Committee.

Observations and reflections: It was considered necessary to restructure the Forestry Committee from the promulgation of the Master Plan of Green Public Spaces of the Aburrá Valley. Determines its functions and members.

- **Agreement 23 of 2012 - Public policy Medellín green and sustainable city**

Objectives and object: To create the Medellín Green and Sustainable City Public Policy. Prioritizes environmental actions and criteria in all sectors (26 orientations).

Actors: Secretary of the Environment (Lidera). They support secretariats of Citizen Culture, Finance, Health, Public Works, Transport and Transit, Planning and Education. The Metropolitan Area, the Urban Development Company, EPM, Une Telecomunicaciones, Metro, Isvimed, ACI, Corantioquia, Empresas Varias, Cultura E, Inder among others may be an integral part of the working groups and in the definition of the guidelines.

Mechanisms and instruments: Environmental Audit Programs. Interdisciplinary Working Group. Monitoring Committee to the strategic program of sustainable development that relates to citizenship, government and scientific community.

Observations and reflections:

- Policy not expressly formulated for the management of urban green. Broader purpose of the city's environmental sustainability. Promotion of sustainability practices in all development sectors. Comprehensive policy, with important aspirations for integration and sectoral harmonization.
- It contains "indicators" (many do not strictly meet this definition) in relation to the following topics: climate change, sustainable construction, sustainable transport, sustainable land use, biodiversity, air quality, noise pollution, solid waste, watershed protection, eco-innovation, environmental management of the local authority, energy efficiency, growth of urban and rural green areas, ecological guidelines for conurbated municipalities, morbidity and mortality associated with environmental health, ecotoxicology.



- Of the 26 orientations, the following stand out in relation to green infrastructure and ecological structure: noise mitigation function (especially in neighborhoods, urbanizations and road corridors), consolidation of the Metropolitan System of Protected Areas, relocation of homes located in retirement areas, promoting green and productive roofs, walls, walls and terraces, execution of proposals for previous Agreements (Ecoparks of Borde, Planting a Tree Save the Planet, Schools Adopt a Park and a Quebrada, El Barrio oxygenates your city and others), promote through all activities the increase in the indices of public space and green area per inhabitant", among others.
- Seeks to influence through orientations and unified language, through the Metropolitan Area, in the other municipalities of the Aburrá Valley. The claim to transcend political-administrative boundaries is valuable, but it is pertinent to ask about the framework of competences to put this agreement into practice in municipalities other than Medellín.
- It would be valuable to know if they were formed, operate, and there are management balances of the established instances and committees, to review results and possible proposals for the Renaturalization Plan.
 - **Decree 1213 of 2014 - Regulates the green and sustainable city policy (23/12)**

Objectives and purpose: Regulate Agreement 23 of 2012, green and sustainable city policy. Harmonization and mechanisms for policy and institutional action in environmental matters.

Actors: Municipality of Medellín, without explicit differentiated responsibilities.

Mechanisms and instruments: Environmental Council of Medellín (CAM). Inter-institutional Thematic Committees (12 in total, each with a coordinator). Instances derived from SIGAM, articulator of environmental policies, programs and projects. Conceptual and methodological framework for monitoring indicators (SMA Manager). Policy Compliance Assessment Program (CAM Manager).

Observations and reflections:

- Recognition of the need for coordination of the environmental policies of the Municipality (among others, PAM, POT, PD, PGIRS, ODM, OAM).
- Recognition of the need for harmonization with other convergent standards with the purposes of 23/2012: SIGAM, Public Policy for the integral protection of fauna; promotion of the recovery of solid waste and dignification of recuperators; debris management, Environmental Education; Medellín city Garden of America, Environmental Tables, Planting a Tree Save the Planet, Emergency Care for Adverse Weather Events that affect agricultural producers in the Corregimientos, Schools of Medellín Adopt a Park and a Quebrada, among others.
- Determines that the indicators of follow-up to this policy must be those contained in the GPA and the PDM (includes them in Art. 3)
- Establish implementation phases. First: harmonization and coordination, by SMA (will define the conceptual and methodological framework through which the monitoring of the indicators is carried out); Second: Socialization and dissemination (in Mayor's offices) of Agreement 23 of 2012; Third: Implementation of a compliance verification program by the



CAM-Municipal Environmental Council; Fourth: Dissemination of "Medellín Green and Sustainable City" to the conurbados municipalities of the Municipality of Medellín, under the supervision and accompaniment of the competent environmental authorities, in order to articulate their local environmental action plans with the provisions of Agreement 23 of 2012 and regulations.

- Low additionality of Agreements 23 and the present. Overlap with SIGAM. Valuable recognition of the need for regional policy, but possible overreach of functions (AMVA).

- **Agreement 45 of 2012 - Municipal Public Policy on Environmental Education**

Objectives and object: Adopt the Municipal Public Policy of Environmental Education. Creates the CIDEAM (Interinstitutional Committee for Environmental Education of Medellín).

Actors: Ministry of Education. Ministry of the Environment. CIDEAM (Environmental educational organizations, health, planning, organized civil society, ethnic groups, research institutes and entities, private sector production unions, Medellín Council, Control Agencies, Environmental Authorities, public and private universities, decentralized entities, family compensation funds and non-governmental organizations with competences in the subject and interest in participating).

Mechanisms and instruments: CIDEAM. Environmental Educational Plan. PRAE, PRAU and PROCEDES (School Environmental Projects, University Environmental Projects, Citizen Environmental Education Projects). Mandatory Environmental Social Service.

Observations and reflections: Define specific objectives, conceptual lines and strategic lines of the Policy that are of interest for a strategy and a renaturalization plan for Medellín. Unlike many agreements and decrees, this one includes a conceptual basis and a higher level of detail in its sustenance and purposes. It mentions the conventional instruments and sources of financing for environmental management, without detailing the specific mechanisms that allow the implementation of the Policy to be effective.

- **Agreement 010 of 2014 - Medellín's Biodiversity Policy**

Objectives and purpose: Adopt the biodiversity policy of the Municipality of Medellín. Biodiversity and ecosystem services of interest to Medellín. Institutional articulation for its management.

Actors: Secretariat of Environment of the Municipality (leads). Corantioquia, Metropolitan Area of the Aburrá Valley, Alexander Von Humboldt Biological Research Institute, National Natural Parks of Colombia, Explora Park, Medellín Botanical Garden, Santa Fe Zoological Park, the Antioquian Society of Ornithology -SAO, Ministry of Environment of the Interior. Articulation with the SIGAM and all the Comitthat make it up.

Mechanisms and instruments: Inter-institutional Technical Table on Biodiversity for Medellín.

Action Plan. Thematic and territorial agenda for research on biodiversity and ecosystem services.

Observations and reflections: Define principles, strategic objectives, instance of articulation, and objectives of that instance. Indicative and sufficient in relation to the approach and



diagnosis of support, but imprecise in terms of the Action Plan and its financing and monitoring.

- **Agreement 48 of 2014 - Territorial planning plan**

Objectives and object: Adopt the Territorial Planning Plan for Medellín. Scope of application: Structuring and structured systems of the territory. Public space. Greenery. Habitat and housing. Urban and rural land.

Actors: Administrative Department of Planning.

Mechanisms and instruments: Consultative Council on Territorial Planning. Municipal File. Execution Program.

Observations and reflections: Fundamental norm for the Renaturalization Plan, which establishes the conditions of urban development for the city, and the opportunities and limitations for the generation, maintenance and qualification of green public space.

Article 7 presents territorial bets directly connected with the purposes of a Renaturalization Plan, namely: Ecological urbanism as a strategy for adaptation and mitigation to climate change, and Consolidation of the spatial physical system, in which the ecological structure of the territory has a preponderant role.

Article 8 sets out strategic objectives, among which 4 are especially relevant for a plan to renaturalize Medellín: *3. Preserve the Main Ecological Structure as a structuring element of the territory that constitutes the basis of life. 4. Promote the development of a resilient territory that gives priority to the attention of risk factors and situations in areas of greater social vulnerability, favoring the implementation of mitigation measures. 5. Consolidate the public space as a structuring element of the territory and a factor of enrichment of daily life and meeting place of the population and in the main ecological structure and the elements of the Subsystem of Immovable Cultural Heritage. 7. Support and promote rural development through sustainable and agroecological production through family farms, seeking to configure a system of food security and sovereignty, in harmony with environmental protection, biodiversity, resources and environmental services, as well as the characteristics of their habitat in the metropolitan environment, for the sustained improvement of the quality of life of the rural population, seeking to ensure an effective and efficient contribution of the rural economy to the development process.*

Article 9 sets out the components of the occupation model, among which the following stand out for the Renaturalization Plan: *2. A territory ordered around the ecological structure, interconnected to the Centrality Subsystem, through a system of sustainable mobility and collective public transport, which supports environmental and spatial functioning, promotes economic productivity and territorial competitiveness and enhances collective identity and memory; 4. A rural area integrated into the regional environment, which hosts functions of ecological protection, production of environmental goods and services; that maintains traditional rural landscapes and in a regulated and localized way, guides and manages the processes of occupation in coexistence with the main rural activities; 5. A diverse rural border that articulates urban-rural dynamics, protects its landscape values, seeking the constitution of a limit for urban growth with environmental interventions that generate citizen appropriation. 6. An urban border with consolidated neighborhoods with high housing quality progressively*



reducing the conditions of threat and risk, articulated to the main ecological structure and the different physical spatial systems; 8. A corridor of the Aburrá River that offers great urban vitality, epicenter of the metropolitan public space, which concentrates the highest urban densities becoming the greatest scenario of social and economic diversity, which boosts local and regional competitiveness.

Article 10 sets out the territorial strategies, among which the following are particularly relevant to the Renaturalization Plan:

Regional:

b) Implement the metropolitan green belt and specify a metropolitan structuring ecological system as a natural base providing ecosystem services and as an adaptive strategy to the situation of climate change.

Municipal:

(a) Incorporate mechanisms for coordinated institutional action, mitigation and adaptation to climate change and risk management.

d) Consolidate the subsystem of public space, incorporating the areas of the main ecological structure susceptible of use for citizen encounter, as well as those properties of opportunity that are located throughout the municipal territory, articulated to the system of centralities.

Rural:

a) Intervene in suburban soils, such as population centers, suburban road corridors, areas for equipment, areas of high pressure in transformation and those that require improvement of rural habitat and environmental sustainability, through the implementation of Rural Planning Units.

b) Establish the policy of sustainability of rural soils by promoting the provision of environmental goods and services and configuring the system of equitable distribution of burdens and benefits with urban land.

Urban edge:

Implement the Comprehensive Neighborhood Improvement program, prioritizing areas with risk conditions and greater socio-economic, environmental and urban vulnerability. Rural Edge: Create a system of highly appropriation edge ecoparks, through the metropolitan green belt, in order to protect areas of landscape and environmental value, contain urban expansion and discourage suburbanization

Urban hillside:

a) Implement green corridors for mobility and ecological and landscape connectivity, in favor of the balance between environmental functions and urban occupation.

c) Qualify neighborhoods and centralities, promoting urban compactness, with the proximity of places of habitation, work and urban services to each other, through comprehensive urban projects in the hillside area, prioritizing the location of facilities, public spaces and infrastructures.



River:

c) Strengthen the urban support infrastructures and the articulation of the areas for the preservation of infrastructures and the public and collective system -API- on the longitudinal corridor, improving the spatial and functional qualification of the city.

It defines the protection soil in the urban and expansion land (art. 14), and rural (art. 16 and 17), which includes the areas of the ecological structure and the risk areas, key to the renaturalization of Medellín.

It defines the main and complementary ecological structure, as well as its classification and categories, and its management criteria (art. 19 to 51), and the classification, zoning and management of the areas of threat and risk (art. 52 to 60).

For the Renaturalization Plan, the consideration of the Strategic Intervention Areas (art. 61 to 64) to be developed through intermediate planning processes called Macroprojects is strategic. It specifies and refines actions that can significantly transform (for better or worse) green public spaces, by interpretive margins or relativization of objectives and functions of the ecological structure of Medellín.

Articles 66 to 94 present the definitions, classification, and management of the subsystem of public space, fundamental for the Renaturalization Plan, and between articles 95 to 132 the guidelines and general rules on equipment in all its categories. Other fundamental orientations due to their direct and indirect impact on green infrastructure and ecological structure are related to the subsystem of Real Estate Cultural Heritage (articles 133 to 156), mobility and transport (art. 162 to 210), and housing system (art. 211 to 230), urban treatments (art 231 to 239), land uses (art. 240 to 256), urban obligations (303 to 326), environmental criteria for urban actions (Article 330), rural treatments (Article 387 to 395), rural uses (art 396 to 416), urban planning obligations on rural land (art 426 to 431), complementary planning subsystem (art 454 to 485), land management and financing instruments (art 486 to 538), administration, maintenance and economic development of Public Space (art. 539 to 544), Environmental System, Risk Management and Climate Change.(art. 545 to 585), and participation component (art. 599 to 606).

The POT is complemented by other administrative acts, among which it is worth highlighting Decree 471 of 2018 on regulatory standards for the actions and processes of urbanization, parceling, construction, and recognition of buildings, which potentially affect the green infrastructure and the ecological structure of Medellín.

- **Agreement 41 of 2015 - Ecological corridors for avifauna**

Objectives and purpose: Create the program "Ecological Corridors for Avifauna" with the aim of promoting and stimulating the conservation, reproduction, environmental protection and migration of birds in the city of Medellín, both in its urban and rural environment, in the same way, to create awareness about its relevance and send an ecological message to the inhabitants of Medellín about the importance of the care and preservation of said fauna.

Actors: Ministry of the Environment. Secretariat of Physical Infrastructure. Metropolitan Area of the Aburrá Valley. Antioquian Society of Ornithology. Institute of Biology and Herbarium University of Antioquia.



Mechanisms and instruments: Comprehensive and multidimensional system of strategies to promote the creation and strengthening of natural ecological corridors. Periodic updating of the forest inventory in the urban area and its implementation in rural areas will be sought. Population inventory of the birds of Medellín both in its rural and urban environment. Monitoring and control of invasive bird species. Days of awareness, socialization, education, communication and information to raise awareness about the problems associated with feedlots for avifauna and the need to refrain from their implementation by the community. Strategies to promote ornithological tourism and bird watching in the city. Municipal technical committee for the study of birds in Medellín. "Brotherhood Agreements" with cities that also actively participate with the protection of birds.

Observations and reflections: Mention is made of species that are considered to offer habitat and food to birds (*Cecropia peltata*, *Erythrina edulis*, *Passiflora nitifolia*, *Cissus microcarpa*, *Siphocampylus retrorsum*, *Guzmania diffusa* and some others not referenced in the Agreement). It connects its implementation with the objectives and actions of Municipal Agreement 31 of 2011 (Program "The streams recover their natural channel"), Agreement 23 of 2012 (Public Policy of Medellín Green and Sustainable City), and Agreement 48 of 2014 (Territorial Planning Plan). He gave 3 months for its regulation. It is unknown if this was done. Non-specific in its financing. Subject to availability of resources and items allocated in the Development Plan.

- **Agreement 042 of 2015 - Sustainable and productive green terraces**

Objectives and object: Sustainable and productive green terraces. Public buildings or decentralized entities. Private buildings of entities with which agreements can be developed. It is suggested in principle to associate them with the corridors of the Metrocables, for their visual accessibility and landscape function.

Actors: Ministry of the Environment. Secretariats of Citizen Participation and Economic Development. Administrative Department of Planning.

Mechanisms and instruments: Technical study that recommends the ideal or priority areas for its implementation.

Observations and reflections: Define the focus of the program. It emphasizes food safety functions, microclimatic regulation, habitat conservation, landscaping, and environmental education. The specific intention of the Agreement is not very clear, beyond a diffuse and strategy less promotion of the importance and relevance of the terraces, nor the need to prioritize their implementation, beyond the corridors associated with the Metrocable. The implementation is sought in private properties and the responsibility or interest is limited to the installation, leaving the maintenance (and eventually the restitution of materials) to the private. Doubts about the viability/legality of public investment ("the Municipal Administration within the framework of the agreement that is established may contribute to the maintenance costs of the green terrace"). Its implementation is considered in both urban and rural areas. It is proposed that the intervention must be in accordance with the TEP and the Forestry Manual. The possibility is raised that the Administration contributes to the commercialization of possible surpluses (food) of the terraces. It mentions the need for regulation of the Agreement, including a study to prioritize areas, but does not define a deadline for this.



Important initiative but still little developed. The Renaturalization Plan is an opportunity to build the criteria, spatial priorities, and define instruments for their implementation.

- **Agreement 46 of 2015 - Management of Climate Change and Climate Variability in the Municipality of Medellín**

Objectives and purpose: Implement the "Comprehensive Strategy for the Management of Climate Change and Climate Variability in the Municipality of Medellín" in order to prevent, mitigate and adapt to these effects and increase resilience and reduce factors that put life, environment and infrastructure at risk. All of the above with the aim of improving the environmental health of the inhabitants of the Municipality of Medellín.

Actors: Ministry of the Environment. Administrative Department of Planning. Secretariat of Citizen Culture. Ministry of Education.

Mechanisms and instruments: International carbon market funds as a financing mechanism for the strategy. Mitigation and Adaptation Plan to Municipal Climate Change. Inter-institutional Thematic Committee on Climate Change of SIGAM. Brotherhood agreements with "green cities".

Observations and reflections: It propose two axes (adaptation and mitigation) as part of the Strategy, with convergent lines of action with a strategy and renaturalization plan for Medellín.

In the adaptation strategy, 6 lines of action are proposed, among which 4 stand out for their convergence with the objectives of a renaturalization plan: *1. Integral intervention of streams to protect human life and ecological heritage. These interventions include improving the hydraulic capacity of the streams, as well as relocating settlements to high-risk areas; 2. Protection of biodiversity: Fauna and flora. Through the correct management of protected areas, the restoration of biodiversity and the protection of strategic ecosystems; 3. Protection of watersheds and micro-water basins. Especially the basins supplying drinking water for the city, in order to guarantee the provision of water for citizens in the face of extreme changes in the climate. 5. Avoid and discourage urban growth towards the slopes and in the rounds of the ravines, through the implementation of light infrastructure and maintenance of ecological development spaces such as eco-orchards, eco-parks, operation of environmental classrooms and awareness; in order to prevent new informal settlements.*

In the mitigation strategy, one of the 6 lines of action stands out for its relevance to the strategy and the renaturalization plan: *6. Sustainable construction. Promote the use of environmentally sustainable buildings, not only from the optimization of construction methods and processes, but also from the improvement of the various aspects that compose and involve them such as: the design, the useful life of the buildings, the location, access to efficient public transport and energy efficiency, among many others similar.*

Of special interest is Article 5, which mentions the need to implement *"massive planting of trees and recovery of flora and fauna in rural and urban areas of the municipality, with the aim of promoting the entrapment of CO₂, greenhouse gases and increased water production, in order to avoid erosions and mass movements. Green roofs, green roofs or landscaped roofs in buildings should be encouraged, which are technologies used on roofs to improve habitat or save energy consumption."*



Indefinite in its financing, beyond the usual references to the budgetary availability and the reserve of resources by the entities responsible for its implementation. A period of three months was defined for the regulation of this agreement. It is unknown whether this was done and the results of its implementation to date.

- **Agreement 047 of 2015 - Strategy for the generation and maintenance of public spaces that promote tree and green soil compensation**

Objectives and objective: Create a strategy for the generation and maintenance of public spaces that promote tree compensation and green soil in the municipality of Medellín. Public spaces. Tree and green soil compensation.

Actors: Ministry of the Environment (leads). Secretariat of Physical Infrastructure. Administrative Department of Planning. Secretariat of Management and Territorial Control (function of surveillance and control of the actions of urban curator ships in the application of urban regulations). Government Secretariat (control function and necessary steps for the recovery of green public space)

Mechanisms and instruments: Methodology of multidimensional assessment of green spaces (by SMA, SIF, DAP). Campaign to maximize the use of public space to turn it into an effective green area (based on the Urban Forestry Manual for Medellín and the Public Space Manual). Public Spaces Management System (SGEP) currently administered by the Secretariat of Physical Infrastructure and the Urban Tree System (SAU) in charge of the Ministry of the Environment (tools to manage, order and manage green public spaces in the municipality of Medellín).

Observations and reflections: Institutionalize the "strategy for the generation and maintenance of public spaces that promote tree and green soil compensation in the municipality of Medellín." Recognizes your direct connection to the POT. Define 5 objectives for the Strategy. It defines various competences and competitions between SMA, SIF, DAP. It recognizes the need to generate new epv (and recover underutilized cash ep). Recognizes the need for all public works to follow the guidelines established in the Urban Forestry Manual for Medellín, the Public Space Manual, urban and environmental regulations (SMA articulation, SIF, Management and Control, DAP, environmental authorities and urban curator ships). Pending regulation (there was a period of 3 months since November 2015).

- **Decree 1152 of 2015 - Calculation, obligation, and collection of urban obligations to be compensated in money.**

Objectives and object: Procedure for calculation, obligation, and collection of urban obligations to be compensated in money. It does not apply to the urban planning obligations that in the respective urban planning license and in the plans that served as support, are indicated as areas of cession destined to public roads, recreational green areas or effective public space.

Actors: Secretariat of Management and Territorial Control. Undersecretary of Urban Control. Undersecretary of Treasury of the Ministry of Finance. Administrative Department of Planning. Undersecretary of Cadastre.



Mechanisms and instruments: Until the Municipal Administration issues the general regulations applicable to the instruments of the Financing Subsystem, contemplated in articles 499 and following of Municipal Agreement 48 of 2014, the collection, administration and direction of the resources obtained by way of payment of urban obligations offset in money will be governed by the provisions of Municipal Decree 2167 of 2014.

Observations and reflections: Define competences in matters of liquidation and verification of compliance with urban planning obligations. Some of these obligations correspond to public spaces, which is why it is of interest to the Strategy and the Renaturalization Plan of the city. Review the relevance of this standard, in accordance with the provisions of the objective item and object.

- **Decree 2148 of 2015 and Decree 522 of 2018 - Economic use of public space**

Objectives and purpose: Regulate the economic use of public space, sets remuneration for its use. Constituent areas of public space and its complementary elements. Applies to the qualification and planned and systemic sustainability of public space and the urban landscape; for the administration with the possibility of making improvements; for its maintenance and preservation; for the realization of activities with or without lucrative use.

Actors: Administrative Department of Planning. Ministry of Finance (Undersecretary of Treasury). Secretariat of Security and Coexistence (through the Undersecretariat of Public Space). Agency for landscape management, heritage and public-private partnerships. Secretariats of Environment, Physical Infrastructure, Supplies and Services, Economic Development, Mobility, Health.

Mechanisms and instruments: Intersectoral Advisory Commission of Public Space (body in charge of knowing, analyzing, conceptualizing, making viable and managing the proposals for intervention, administration, maintenance and economic use of public space, whether of public or private initiative). Technical committee. Interdisciplinary and inter-institutional study tables. Administrative act that authorizes the performance of an activity or the legalization of the contract of use of the ep. Strategic Management Council of the Territorial Planning Plan, with the support of its Technical Committee. Manual of procedures for the Economic Use of public space. Urban environmental protocols. Sustainable Building Code (orders its preparation and approval. Meanwhile, it implements the AMVA's sustainable construction policy.) License of intervention of the public space. National Police Code and Territorial Planning Plan.

Project of occupation of the public space. Technological Platform and Geodatabase for the Management and Administration of the Economic Use of Public Space of the Municipality of Medellín. Strategy for the economic use of public space, in which areas or zones of the city are contemplated for the gradual implementation of the Decree (in charge of the PPP of Medellín).

Observations and reflections: Within the areas with prohibitions for economic exploitation it is said "... *in all spaces that present floor cover, pits and tree species*". If, due to the intervention license granted, the elimination of vegetation cover or tree species is admitted, it must be compensated in accordance with current regulations. "*Green areas and arborization may not be used for any economic purpose, vehicle parking, storage and the like, except for the location of fences and notices according to current regulations.*"



The occupation of these spaces susceptible to economic use must comply with the regulations defined in the POT and complementary planning instruments, guaranteeing among others the permanence of the urban ornament, the green areas or vegetal cover of floor and tree mass, the protection of natural resources and the areas or properties of patrimonial protection.

The occupation, intervention and qualification of public space must accommodate the determinants established in the Urban Forestry Manual, and in the other instruments that implement or develop it, as well as the metropolitan guidelines, such as the Guidelines of Public Policy of Sustainable Construction "(AMVA & UPB, 2015b) and respective guides.

As temporary use of public space, the occupation of the ante-gardens with tables and chairs is also understood as an extension of the activities of the commercial premises, which are allowed, according to their location within the structuring system of the public space, the uses established in the Territorial Planning Plan, complying with current regulations or those that modify or replace it.

It defines contracting modalities (Art. 11), variables and method for the economic valuation of the economic use of public space (Art. 12 and 14), discounts for good environmental practices (up to 10%) (Art. 14A), specifically criteria and actions of environmental and landscape qualification of public space, technical *feasibility* for the AEEP (Art 17), inventory record of public space subject to temporary and transitory use (Art. 22).

Important standard to evaluate *opportunities* in relation to the maintenance and sustainability of green public space in the city. The phenomenon of unregulated and informal occupation of public space is growing, and deserves greater action and attention within the framework of a renaturalization plan for the city.

- **Decree 883 of 2015 and Agreement 01 of 2016 - Administrative organization of the Municipality**

Objectives and object: Adaptation of the structure, organization and functioning of the municipal administration of *Medellín*. It establishes the functions of its decentralized agencies, dependencies and entities.

Actors: Secretariats and Undersecretaries. Colegio Mayor de Antioquia, Instituto Tecnológico Metropolitano -ITM-, Instituto Tecnológico Pascual Bravo, Instituto de Deportes y Recreación de Medellín -INDER-, *Biblioteca* Pública Piloto, Museo Casa de la Memoria, Unidad Administrativo Especial Con personaería jurídica, Agencia para la Educación Superior -SAPIENCIA-, Metroparques, Fundación Ferrocarril de Antioquia, Parque Explora, Hospital General de Medellín -E.S.E-, Instituto Social de Vivienda y Hábitat de Medellín -Isvimed-, Aeropuerto Enrique Olaya Herrera, Empresa de Desarrollo Urbano -EDU-, Terminales de Transporte de Medellín S.A, Corporación Cuenca Verde, Corporación Parque Arví, Fundación Jardín Botánico "Joaquín Antonio Uribe", Ruta N, Telemedellín.

Mechanisms and instruments:

It defines the Secretariat of the Environment-SMA as a dependency of the central level (Sector of administrative development of habitat, mobility, infrastructure and sustainability) that will be responsible for defining and implementing *environmental* policies, as well as the planning, design, coordination, execution and evaluation of strategies related to the conservation,



recovery and protection of renewable natural resources and their environmental sustainability. It assigns to the Undersecretariat of Renewable Natural Resources the following responsibilities and functions:

- *Define and execute environmental plans, programs and projects related to natural resources, which guarantee the conservation, recovery and protection of renewable natural resources.*
- *Develop the necessary actions to improve the quality of natural resources and encourage the appropriation of green public spaces.*
- *Lead and manage the necessary actions for the protection, conservation and promotion of green public spaces, landscaping and forestry in the Municipality of Medellín.*
- *Implement actions in compliance with air and noise decontamination plans.*
- *Implement and execute policies and guidelines that guide support processes.*
- *Implement and execute the policies and guidelines that guide the TEP in the scope of its functions.*

Observations and reflections: The following reflections are based on the evaluation carried out by the Inter-institutional Thematic Committee on Environmental Quality of the Habitat of Medellín of SIGAM, on the responsibilities and functions of each of the agencies and dependencies that make it up; associated with habitat and the mainstreaming of environmental policies, disaster risk management and adaptation to climate change:

Under recognition and positioning of the Environmental Management System of Medellín - SIGAM, as a strategic tool for the harmonization of municipal environmental management. The SIGAM is not considered an instance of consultation or consultation for the TEP and is not subject to permanent updating. This results in little articulation and continuity of the Municipal Environmental Plan - PAM and the occupation model defined by the POT, in the Development Plans of the different administrations.

Weak inter-institutional and intersectoral articulation. Although coordination and articulation mechanisms have been created in environmental and disaster risk management, there are difficulties in their implementation since each agency responds to management styles that are sometimes not compatible.

Lack of clarity in guidelines and guidelines associated with environmental management, due to the multiplicity of policies and their outdated.

Finally, the formulation of the renaturalization plan must consider an intra- and inter-institutional articulation that allows generating assertive communication channels between the different dependencies with interference in the management of urban and rural green (Ministry of the Environment, Secretariat of Physical Infrastructure, Ministry of Health, Ministry of Finance and the Administrative Department of Planning), as well as clear guidelines for action that avoid fragmentation of function is and that allows each unit to communicate and visualize its management, around the common objective of efficiently managing green.

The Ministry of the Environment must consolidate itself as a leader in the management, planning, design and execution of strategies related to the conservation, recovery and protection of renewable natural resources, as enshrined in Article 298 of Decree 883 of 2015.



However, the functions developed, as far as green management is concerned, are in the order of the instrumental and operational, leaving aside the planning component.

- **Decree 1240 of 2015 and Decree 665 of 2016 - Municipal Disaster Risk Management Plan**

Objectives and object: Municipal Disaster Risk Management System, Municipal Disaster Risk Management Plan, Municipal Strategy for Emergency Response and the Incident Command System. The scope of application is that of the areas of threat, vulnerability, and risk for different phenomena. Institutions of the Disaster Response System.

Actors: Mayor of the Municipality of Medellín. DAGRD. Ministry of Communications, Finance, General, Supplies and Services, Government, Safety, Health, Social Inclusion and Family, Physical Infrastructure, Environment, Mobility, Territorial Management and Control, ISVIMED, EPM, METROMED, Corantioquia, AMVA, Administrative Department of Planning, Medellín Firefighters, Colombian Civil Defense Regional Antioquia, Colombian Red Cross Regional Antioquia, Metropolitan Police, Fourth Brigade.

Mechanisms and instruments: Municipal Plan of GRD (validity of 8 years). Specific Action Plan for Recovery (Art 29). Actions to avoid risk reactivation and resettlement. CMGRD (Municipal Council for Disaster Risk Management). Municipal Committee for Knowledge and Disaster Risk Reduction. Municipal Committee for Disaster Management. Technical Commission. Habitat Management Commission. Social Protection Commission. Health Commission. Education Commission. Search, Rescue and Rescue Commission. Technological Risks Commission. Resource Management Committee.

Observations and reflections: Knowledge and risk reduction component are more clearly related to a renaturalization strategy and plan. Possible source of information: Technical Commission (systematization of information on risk knowledge). SMA participates in many of the defined commissions, so it would be an internal dialogue to glimpse the possible articulation with the Renaturalization Plan. Habitat Management Commission is key to the process of formulating and implementing the Plan.

- **Agreement 39 of 2015 - Bird Festival**

Objectives and object: Institutionalize the "Festival de las Aves" to create a new city culture and promote that through the different strategies to be implemented Medellín is visible, nationally and internationally, as the city of birds. The above, with the aim of making citizens live experiences related to education, environmental culture and awareness of the natural heritage that the city and the region have, as well as reaching a diverse public that finds in an event like this an option for recreation, learning, communication, research and conservation of biodiversity; being clear that only what is known is protected, it is vital to seek the integration of scientific knowledge with cultural events and city spaces to promote the dissemination of knowledge of the diversity of birds that this territory houses.

Actors: Secretariats of Environment, Citizen Culture, Undersecretariat of Tourism of the Secretariat of Economic Development.



Mechanisms and instruments: Development, implementation and execution of strategies for awareness, socialization, awareness, education and information on the need for the care and preservation of birds.

Observations and reflections: Event of awareness and management of knowledge about birds that was proposed to be held every October in Medellín, through cultural and scientific activities, organized in five different typologies. Relevant as an opportunity for communication and appropriation about the flora and green public space in the city, as well as its problems and management advances. It could be complementary to Agreement 041 of 2015 (Ecological corridors of avifauna). Indefinite in its financing, beyond the usual references to the budgetary availability and the reserve of resources by the Secretariats and entities responsible for its implementation. It requires regulation but does not set a deadline for it. The balance of its implementation is unknown.

- **National Decree 1625 of 2016 – Only regulatory of the tax sector**

Objectives and purpose: To compile and rationalize the regulatory rules that govern the Finance Sector and to have a single legal instrument for it.

Actors: Ministry of Finance and Public Credit, Municipal Finance Secretariats, Directorate of National Taxes and Customs –DIAN.

Mechanisms and instruments: below are the articles that may have an impact on the implementation of NBS at the private level in a future Renaturalization Plan, to the extent that they offer tax relief for individuals who make investments in different matters related to environmental control and improvement.

Articles 1.2.1.18.51 to 1.2.1.18. 56. Deduction of income and supplementary tax. For the inversions in control and improvement of the environment. Among which are: Investments in the framework of projects aimed at the control of the environment or the restoration, recovery, regeneration, repopulation, protection and conservation of renewable natural resources and the environment.

Acquisition of land and/or land necessary for the sole and exclusive execution of environmental protection and management activities, in accordance with the provisions of the national environmental plans and policies contained in the National Development Plan and/or formulated by the Ministry of Environment and Sustainable Development, or regional environmental plans defined by the respective environmental authorities, as well as those for the constitution of Natural Reserves of Civil Society.

Acquisition of land and/ or land for the recovery and conservation of water supply sources by Public Utilities.

Articles 1.3.1.14.3 to 1.3.1.14.10: Exclusion from Sales Tax. Goods Excluded from Sales Tax: National or imported equipment and elements that are intended for the construction, installation, assembly and operation of control and monitoring systems, necessary for compliance with the provisions, regulations and environmental standards in force, for which such condition must be accredited to the Ministry of the Environment

Imports that do not cause sales tax The importation of machinery or equipment, provided that such machinery or equipment is not produced in the country, intended for recycling and



processing garbage or waste (machinery includes washing, separating, recycling and extrusion), and those intended for the purification or treatment of wastewater, atmospheric emissions or solid waste, for recovery, as long as they are part of a program that is approved by the Ministry of the Environment. In the case of contracts already concluded, this exemption must be reflected in a lower value of the contract.

Articles 1.2.1.5.1. to 1.2.1.5.8. Exemption from income tax for the net profit or surplus of taxpayers with special tax regime (corporations, foundations and non-profit associations, whose main corporate purpose is the realization of activities of health, sports, formal education, culture, scientific or technological research, ecological, environmental protection or social development programs. That the activities carried out are of general interest, that is, that they benefit a population group, such as a sector, neighborhood or community).

Observations and reflections: The formulation of the Renaturalization Plan should consider this regulation in tax matters, especially for the promotion of Nature-Based Solutions in private properties.

- **Decree 1910 of 2016 (modified by Decree 602 of 2018) - Payment for water environmental services**

Objectives and purpose: regulate the application of the payment scheme for water environmental services. It is defined as the incentive that the Municipality of Medellín will contractually recognize to the owners and regular owners of properties located in areas of strategic importance for the conservation of water resources, with conservation treatment, for the recovery of natural ecosystems and the provision and / or improvement of environmental services, within the framework of the implementation of the instruments of compensation of urban burdens of the Management System for Territorial Equity defined in Agreement 48 of 2014.

Actors: Secretariat of the Environment, Council of Strategic Direction of the Territorial Planning Plan, Ministry of Finance, civil society (owners and regular owners of properties).

Mechanisms and instruments: The mechanism operates for properties larger than two (2) hectares.

Properties smaller than two (2) hectares will be individual beneficiaries of the incentive, if the SMA considers it strategic due to its particularities and contribution to the protection of water resources. Likewise, these properties may be beneficiaries from joint applications with adjoining properties that total a minimum area of two (2) hectares.

With this Decree, the "Map of eligible properties" is adopted as an instrument to facilitate the identification of the properties that may benefit from the water PSA (overlapping of areas of strategic importance for the conservation of water resources + soils with conservation treatment).

The decree determines the incentive to recognize, from the area to be conserved and / or restored and establishes all the operational mechanisms that make possible the implementation of the instrument, which are related to: call, participation requirements and selection of beneficiaries, admission of applications, legal evaluation, technical visit,



formalization of agreements, recognition of the incentive, duration of the contract, disbursement, monitoring and verification.

The strategic direction of the instrument is in charge of the Strategic Direction Council of the Territorial Planning Plan, created by Municipal Decree 1569 of 2016. While the administration and implementation of the same will be the responsibility of the Ministry of the Environment.

The resources allocated to the operation of the incentive will be executed directly by the Ministry of the Environment, from the creation of a specific destination account, which will be under the responsibility of the Ministry of Finance.

The sources of financing for the instrument correspond to: effective collection of 1% of the current income of the municipality of Medellín (Law 99 of 1998 - article 111). Financial resources in accordance with the provisions of article 108 of Law 99 of 1993, co-financing with the environmental authorities from the items to acquire strategic areas or ecosystems for the conservation, preservation and recovery of natural resources. Voluntary contributions from citizens and/or private sector companies.

Currently the incentive operates with resources from the municipality of Medellín and the More Forests Corporation. An incentive value of SMMLV 1.14 per hectare-year was defined for properties with existing natural forest and SMMLV 2.78 per hectare-year, for properties with areas under restoration (the owner must carry out the restoration. It will be verified that they were not with natural coverage in the last 5years).

Observations and reflections:

It recognizes the need to implement alternative schemes for the protection of water resources. It accounts for the interest of the municipal administration to compensate the urban burdens imposed by the Territorial Planning Plan in terms of conservation and environmental protection and compliance with national and local regulations associated with water PSA (Single National Decree 1076 of 2015. Decree 870 of 2017. Document CONPES 3886 of 2017 and Agreement No. 48 of 2014 - article 527).

According to the information provided by the SMA during the execution of the inter-administrative agreement, with the Más Bosques corporation, for the administration and implementation of the payment instrument for water environmental services, in aqueduct supply basins for the city of Medellín, a total of 51 agreements have been signed that benefit 67 properties, representing 585.92 hectares encouraged to carry out conservation actions and 9.16 hectares for restoration actions. With a total investment of \$476,935,485.

It would be relevant to know the detailed results of the implementation of the instrument in the municipality. As well as the monitoring and evaluation mechanism that is being executed, in order to identify complementarities with the Renaturalization Plan for Medellín, and that in the future will result in greater strategic areas, beneficiaries and / or financial resources.

Greater clarity is required on the sources of financing of the incentive and on the resources to carry out conservation or restoration actions in the beneficiary properties, since the decree establishes as one of the commitments or obligations of the owners or regular holders the development on their property, to the extent of their possibilities, with their own resources or



other sources of financing, best practices for the conservation or restoration of the area of offer of environmental services.

- **Agreement 066 of 2017 and Decree 350 of 2018 - Normativa tributaria para el Municipio de Medellín**

Objectives and purpose: Present the substantive regulations applicable to the taxes in force in the Municipality of Medellín and updates and compiles the procedural regime in tax matters. Understanding that it is the territorial entity that can decide what to do with its own taxes and if applicable, may establish exemptions, special treatments and other benefits, through the Municipal Council.

Actors: Ministry of Finance, Undersecretaries of Revenue and Treasury, Taxpayers.

Mechanisms and instruments: Establish exemption from the payment of the unified property tax until December 31, 2023, for the owners of land protection of the connectivity network and protective forest use, for properties with planted area, reforested, or with native vegetation cover in the Network of ecological connectivity of urban land, as well as for properties with planted area, reforested, or with native vegetation cover in the category of protective forest use in rural land.

The exemption will be granted provided that they comply with the following:

- That contribute to the purposes of protection as established in the Territorial Planning Plan.
- In the ecological connectivity network, by virtue of the protected area, the property cannot be developed urbanistically, prior concept of the Administrative Department of Planning.
- In the protective forest use, by virtue of the protected area, the property cannot be developed urbanistically or implement another economically profitable use, prior concept of the Administrative Department of Planning.
- That the area of land protection of the lot is not part of green areas or areas free of urbanizations and buildings with horizontal property.
- That the property is not part of lots defined as equipment.
- That the current land uses that are developed within them, correspond to what is defined in the POT.

The exemption will proceed for the planted, reforested area or the one that has natural vegetation cover, of the properties that have this declaration, as long as the uses that are developed on them, are oriented to guarantee the sustainability of natural resources, to the maintenance of the offer of environmental goods and services (type of vegetation cover) and to sustainable forest production, in harmony with the zoning established in the respective administrative act by which the declaration is made, provided that:

- The property is located in any of the categories indicated in this numeral.
- There is an area planted, reforested or with natural vegetation cover equal to or greater than fifty percent (50%) of the total area of the property.
- That the land uses that are developed within them correspond to those defined in the POT, and to those defined in the respective administrative act of the declaration.
- That these properties present a type of natural or planted forest cover.



Likewise, exemption for up to 5 years from property tax is established for private properties committed to projects prioritized by the urban operator and previously approved by the DAP, determinants for the realization of the public and collective system defined in the Territorial Planning Plan and its complementary planning instruments (Areas receiving Obligations), for which it must be linked in advance to the Real Estate Bank, or the entity that exercises its functions, in the terms of Agreement 48 of 2014 in Articles 491 and 492 and other rules that complement, modify or replace.

As for the exemption from the industry and commerce tax, this is established among others for the Electric Energy Cluster, in relation to: Innovation in manufacturing in the process and services of luminaires, equipment and elements for lighting with greater energy efficiency. Innovation in the manufacturing in the process and services of clean energy solutions through alternative sources (wind, photovoltaic, solar, thermal or geothermal energy).

Observations and reflections: The formulation of the Renaturalization Plan should consider this regulation in tax matters, especially for the promotion of Nature-Based Solutions-NBS in private properties.

- **Agreement 67 of 2017 - Medellín Environmental Management System**

Objectives and object: Adjust the SIGAM, creates the Territorial Council of Environmental Health - COTSAM, which will be integrated into the Environmental Council of Medellín - CAM. Environmental management and environmental health. Intra- and inter-institutional coordination.

Actors: Ministry of the Environment (Lidera). Ministry of Health. Corporación Parque Arví, Jardín Botánico Joaquín Antonio Uribe, EPM, Empresas Varias de Medellín, ISVIMED, EDU, Metroplús, Metro de Medellín, Metroparques, Instituto de Recreación y Deporte, Parque Explora de Medellín, Sapiencia, Institución Universitaria Colegio Mayor de Antioquia, Instituto Tecnológico Metropolitano - ITM, Institución Universitaria Pascual Bravo. Environmental NGOs, Asoediles (JAL), Territorial Planning Council, Inter-Guild Committee of Antioquia. Environmental tables (zonal and corregimental). With voice but without vote (MADS, SMA Gobant, Corantioquia, Cornare, AMVA)

Mechanisms and instruments: Environmental Council of Medellín (CAM). Inter-institutional Thematic Committees (Water Resources, Protection of Biodiversity and Strategic Ecosystems, Protection of Fauna, Integral Management of Solid Waste, Air, Sustainable Production and Consumption, Environmental Quality of Habitat, Environmental Education, Urban Forestry and Landscaping, Climate Change, Cleaning and Ornamentation). COTSAM. PAM. Leading Group. SIAMED. Participation Subsystem. Articulation with the Municipal Planning System. OAM (Medellín Environmental Observatory), and OSM (Medellín Health Observatory).

Observations and reflections: Define Medellín's environmental policy and its objective. It defines the SIGAM, its functions, and the priorities of environmental management, mission, objective, scope, participants, and operation. It defines the CAM, its functions, members. technical secretariat. SIGAM and PAM, a key instance and instrument for the articulation and integration of environmental action and monitoring strategies. Formulation of the GPA 2020-2032 is an interesting opportunity for the insertion of the indicators and objectives of a renaturalization strategy and plan for Medellín.



- **Decree 113 of 2017 - Manual of Public Space of Medellín**

Objectives and object: Adopts the Manual of Public Space, an instrument of specific and detailed regulations, which complements the Territorial Planning Plan and the local and national regulations in force, general and specific, in relation to the guidelines for the urban, architectural and detail design of the public space of and for the municipality of Medellín, to be applied in the projects and actions of generation, maintenance, recovery, improvement and restitution of public space and other interventions and occupations in it, in accordance with the technical requirements that must be met by the elements that compose it. Scope of application: Urban, expansion, and rural public space. Parks, ecoparks, civic parks, squares, recreational green areas, panoramic viewpoints, separators, roundabouts, spaces distributing pedestrian and vehicular circulation, lateral green areas and interchanges.

Actors: Administrative Department of Planning. Urban Curatorships. City Council.

Mechanisms and instruments: Manual of Public Space. Technical details.

Observations and reflections: General objectives 5 and 6 of the Manual are highlighted for their specific and strategic relevance in relation to a renaturalization plan for Medellín: *"To contribute to the improvement of the environmental quality of public spaces, in urban and rural soils, through the application of criteria of sustainable construction and biotecture, constructive practices that contribute to the prevention, mitigation and adaptation to climate change, providing spaces for the meeting, recreation and mobility of the population in a comfortable, quiet and safe way, with a high content of the natural component, established in an appropriate way, to achieve, among others, the connectivity of the ecological network. Contribute, according to the dimensions of the public spaces to intervene, with the reduction and control of pollution by particulate matter and gases, solar radiation, by noise; as well as, to the prevention and mitigation of floods and mass movements, to have safer and more suitable places for citizen encounter, playfulness, fun and rest."*

In addition, specific objectives 5 to 8: *"5. Locate safely, with technical, landscape and spatiality criteria, the components of the Subsystem of Household Public Services, public lighting and other networks or infrastructures of services to be installed in the public space. 6. Give precedence to the establishment of the components of biotecture and use of plant elements in the different construction processes, intervention and occupation of public space, so as to guarantee all users of the same, a comfortable, healthy and safe environment. 7. Specify the criteria of sustainable construction, related to construction developments in all its stages – design, construction, operation, maintenance, transformation and demolition -, for all types of interventions and occupation of public space, in order to prevent, mitigate and adapt its conditions to the effects of climate change. Likewise, define the criteria to avoid and correct visual and landscape pollution, carry out the appropriate management of the arborization for the effects of shade, microclimate and carbon capture; favor and recover the natural permeability of the land, with the purpose of creating the conditions of climatic comfort and safety for the users of the public space. 8. Encourage the use of sustainable materials – with a low ecological and carbon footprint – and encourage the use of reusable or recyclable materials in public space; that comply with characteristics of quality and resistance, that are non-slip for pedestrian and public call uses; that favor the permeability of the soils, that do not*



contain toxic harmful elements - for the health of people, plants and animals, that are anti-reflective and that do not generate heat island".

Manual with guidelines that are dynamic, subject to the possibility of correction, updating, and improvement, processing modifications made by Municipal Planning. This could be an opportunity to include technical *aspects* that, guaranteeing the objectives of the manual, contribute to the implementation of NBS within the framework of the Medellín renaturalization plan. The concept of biotecture is philosophically related to many of the nature-based solutions, so it is possible to think of modifications and complements that enrich an update of the Manual in the future, also considering that the update of the Urban Forestry Manual was subsequent to the adoption of the MEP. Analyze needs and strategies for the promotion of NBS as part of the processes of evaluation, improvement and updating of the Public Space Manual.

- **Agreement 065 of 2017 - Medellín cares, protects and preserves its resources**

Objectives and purpose: Promotion of the design and implementation of measures that promote the rational use of drinking water and the reuse of gray water and rainwater in city buildings.

Actors: Competent authorities at the municipal level. It does not specifically define which ones.

Mechanisms and instruments: Technical document as part of the Territorial Planning Plan and the Sustainable Construction Manual of the Municipality. Program for the efficient use and saving of water. Environmental plan of the municipality. Study of technical feasibility and feasibility of the collection and reuse of rainwater in new buildings owned by the municipality.

Training processes in sustainable construction fundamentals for officials of the Municipality and its decentralized entities that design, build, maintain, coordinate and supervise new buildings for the Municipality.

Observations and reflections: Initiative under which nature-based solutions can be implemented aimed at the rational use of water in buildings and streets. Agreement limited to public buildings. It does not define leadership, competencies and responsibilities. Undefined financing and management instruments. Positive recognition of the need for training on the subject among officials, in view of a greater intensity in the promotion and implementation of these measures. Positive call for the articulation of actions with other planning instruments (Water Savings, Medellín Environmental Plan, POT).

- **Decree 895 of 2018 - Urban forestry Manual for Medellín**

Objectives and object: Adopt the Manual of Urban Forestry for Medellín - Management, Planning and Management of Green Infrastructure. Public space. Manual as a tool of obligatory use for public works.

Actors: Secretariat of Environment (Undersecretariat of Natural Resources), Secretariat of Physical Infrastructure, Administrative Department of Planning.

Mechanisms and instruments: Suggest forming a green infrastructure group. Follow-up by the Forestry and Landscaping Committee.



Observations and reflections: Recognition of the need for standardization of institutional procedures. Draft Decree published for 2 days for citizenship observations. None came. Limited publicity and transparency. It establishes with mandatory character for the city projects and all those developed in Medellín the guidelines, components and procedures indicated by the Manual, in articulation with the Manual of Public Space. Should such articulation be explicit and not tacit? How is this articulation reviewed and materialized in the projects reviewed by the Committee? Based on the experience of this Committee, would an integration of these manuals be desirable, or have they been operating and being applied well independently? Important for the Renaturalization Plan is an intra- and inter-institutional and multi-stakeholder evaluation of the strengths and limitations of the Manual, to identify opportunities for improvement within the framework of the Plan.

- **Agreement 106 of 2018 - Strategic ecosystems of Medellín**

Objectives and purpose: Establish guidelines for the preservation and restoration of Medellín's strategic ecosystems. Scope of application: Drinking water supply basins, tutelary hills, areas of births and outcrops of water, edges and withdrawals of invaded streams, watercourses, rivers, recharge zones, aquifers, wetlands, moors and lakes.

Actors: Ministry of the Environment. Administrative Department of Municipal Planning. Administrative Department of Disaster Risk Management. Ministry of Education. Secretariat of Management and Territorial Control. Secretariat of Citizen Culture.

Mechanisms and instruments: Programs of appropriation and social valorization of the acquired properties. Investment of 1% of current income for the purchase of land or psa for water resource conservation (Law 99). Declaration of public utility of the areas in which resources are invested subject to this Agreement. Areas acquired or supported by the PSA mechanism become protective soils under the terms of Law 388 of 1997. Information on intervened and priority properties (eligible) will be reported to SIAMED. Internal Working Committee in charge of the implementation through an Action Plan or Operational Plan of this Agreement. Prioritized Plan of Strategic Areas to be acquired and protected that must be included in the Territorial Planning Plan -POT- and in the Management and Management Plan -POMCA- of the Hydrographic Basin of the Aburrá River. Plan for the Acquisition of Properties of Strategic Environmental Importance.

Observations and reflections:

- Conceptual confusion in the single paragraph of article 1: "Strategic ecosystems are understood as the areas identified in the POT as the main ecological structure, which defines the protection soil of Medellín". Three different concepts assumed as one.
- Valuable consideration of the need to prioritize spatially the investment of resources and creation of a Commission and a Plan for it. Important inclusion of the possibility of benefiting areas that are outside the jurisdiction of Medellín but are important for the provision of the water resource demanded by the city.
- Doubt about the effects of the declaration of public utility contemplated in article 5, since it establishes a limited period for the purchase of land object of the measure, so it implies a specific budgetary commitment for the Municipality.



- Lack of definition in financing instruments, beyond what is indicated by law (1%).
- In parts of the agreement, water resource conservation objectives are confused with areas of importance for biodiversity, invoking strategies such as SIRAP, Parque Central de Antioquia, and Plan Quebradas. These priority areas may not be convergent in their objectives, so the priority objective should be detailed, without ruling out synergistic objectives, subject to the main one.
- Recognized the need for publicity and dissemination of the Agreement.
- Defined the need for its regulation. It is unknown if it has been carried out, and if there are evaluations of effectiveness.
- Concern about the fact that it is not necessary that properties to be intervened are not included in POT as part of the ecological structure or in the POMCA. Discretion that can be a risk for effective investment. However, it is mentioned that "... other environmental studies and technical reports of the Ministry of the Environment that support their importance may also be taken into account".
 - **Decree 598 of 2019 - Management and protection for the preservation of trees and palms, natural and cultural heritage**

Objectives and object: Management and protection for the preservation of trees and palms, Natural and Cultural Heritage of the Municipality of Medellín. Heritage trees and palms located in public space.

Actors: Ministry of the Environment (obligations to update the inventory and monitoring). Ecological Structure Unit of the SMA. Urban Forestry and Landscaping Committee.

Mechanisms and instruments: Technical data sheets of each individual. List of heritage individuals (historical -227-, notable -94-, and of public interest -376-). Ecological Structure Unit of the SMA (Technical Diagnosis). Committee on Urban Forestry and Landscaping (Approval of Interventions). Urban Tree System (SAU). Inventory update every 4 years (SMA). Dissemination Plan (SMA and SCC).

Observations and reflections: Establishment of cultural assessment criteria for the arboreal natural heritage. Based on article 44 of the POT, but objectives that exceed it (because the universe of management of trees and heritage palms is not subject to the connectivity network established by the POT). Recognition of the heritage values (historical, aesthetic-landscape, ecological) of certain components of urban ecosystems. Definitions relevant to the understanding of the Decree. Definition of silvicultural management actions (recovery, improvement, maintenance) and sociocultural management (education, dissemination, appropriation). Definition of typologies of heritage individuals (historical, notable, of public interest). Definition of competencies for implementation. Definition of objectives and components of a Disclosure Plan (in charge of SMA and SCC).



6.1.2 Description key

- **Agreement 16 of 2006 - Master Plan for Urban Green Public Spaces**

Objectives and object: Adopt the Master Plan of Urban Green Public Spaces of the Metropolitan Area of the Aburrá Valley, as a strategic plan for the integral management in the short, medium and long term, of the green areas and the urban flora (horizon of the plan: 14 years).

Actors: Metropolitan Planning Council, Corantioquia, Cornare, Interinstitutional Committee of Fauna and Flora (CIFFA), Municipal Mayors (Secretariats, Directorates or Planning Offices, Public Works, Environment, Agriculture and Umatas), Botanical Garden of Medellín, Public Companies of Medellín, Environmental Tables, Non-Governmental Organizations (NGOs) of an environmental nature, Asocomunales (Local Administrative Boards- JAL and Community Action Boards- JAC), Universities.

Mechanisms and instruments: the plan establishes a classification system for green public space, makes a diagnosis of urban green public spaces and a proposal for a metropolitan ecological network, and 5 guidelines or basic guiding principles for a policy of management of green public space and urban flora of the metropolitan region of the Aburrá Valley, each of which results in specific programs and projects. The guidelines are:

Policy Guideline 1: Inter-institutional coordination and cooperation in the management of green public space and urban flora. In order to guarantee the agile and adequate flow of communication and information, as well as the quality assurance mechanisms necessary for the management of the system of green public spaces.

Policy Guideline 2 - Sustainable management of green soil and ecological connectivity. Based on actions that allow to expand and sustain the offer or metropolitan urban green infrastructure, increasing the current indices of green public space per capita at the regional and local level.

Policy Guideline 3 - More and better green public spaces through greening and naturalization of the metropolitan urban landscape; through the recognition of the ecological functionality of Green Public Spaces and the articulation of urban planning purposes with ecological processes.

Policy Guideline 4 - Citizen participation for the appropriation and co-management of green public space, based on inter-administrative and inter-institutional programs through which the appropriation by communities of green public space is promoted.

Policy Guideline 5 - Innovation and knowledge for the management of green public space.

Observations and reflections:

The plan institutionalizes and regulates the Metropolitan Committee for Ecology and Urban Forestry. Adopts the proposed economic valuation instrument for the purpose of compensating and promoting green public spaces. And it institutionalizes the Metropolitan System for the Management of Green Public Space and Urban Flora (SIMEG-EPV).



The Agreement does not generate management instruments for the instrumentalization of the Plan. It is established that the Environmental Subdirectorate of the Metropolitan Area will be in charge of leading the processes of concertation between the different public and private entities that are required for the implementation of the programs and projects of the Plan but these responsibilities are not specified.

The agreement does not generate clarity on the appropriation of resources for the implementation of the proposed programs and projects, it is determined that the AMVA will make the necessary management to finance the programs and projects with international cooperation resources. Likewise, the mechanisms that allow the follow-up to the proposed initiatives are not identified and the instruments that allow prioritizing and agreeing projects between the municipal administrations and the AMVA are not specified.

- **Agreement 23 of 2015 - Public policy on sustainable construction**

Objectives and purpose: Adopt the Public Policy of Sustainable Construction as an instrument that allows the effective and permanent incorporation of environmental sustainability criteria in the planning, design, construction, operation and maintenance of the built environment of the Aburrá Valley.

Actors: Metropolitan Area of the Aburrá Valley, Administrative Department of Planning, Ministry of environment, Ministry of Education, Corantioquia, Secretariat of Physical Infrastructure, Social Institute of Housing and Habitat of Medellín, Urban Development Company, EDU, State Companies providing Public Services (EPM), Colombian Chamber of Construction, CAMACOL, La Lonja de Propiedad Raíz, Companies Providing Domiciliary Services, Financial Entities and Compensation Funds, Urban Curatorships, Municipal Administrations, academic community, civil society.

Mechanisms and instruments: The Metropolitan Guides for Sustainable Construction are defined, with applicability during the planning, design and construction stages of infrastructure projects that are financed with resources from the Metropolitan Area of the Aburrá Valley, as long as the application of their elements is technically, legally and financially viable.

1. *Guide to site characterization*
2. *Guide for the inclusion of sustainability criteria in urban planning*
3. *Guide for the inclusion of sustainability criteria in the configuration of open spaces public and private*
4. *Guide to the design and construction of sustainable buildings*
5. *Sustainable rehabilitation guide for existing buildings*

Likewise, it generates the Action Plan of the Public Policy of Sustainable Construction, in which the Public Policy instruments with the greatest feasibility and relevance of implementation were identified and which are specified in four (4) strategic lines:

Line 1. Normative regulation: from the dissemination of the policy and the incorporation of the guides to the basic municipal urban regulations.



Line 2. Fiscal stimulus: promotion of tax benefits and implementation of land management instruments, environmental compensation and municipal tax exemptions.

Line 3. Promotion through the market: through the strengthening of environmental credit lines as a source of financing for technological update and productive improvement projects for companies in the construction sector.

Line 4. Voluntary participation agreements: promotion of the voluntary participation of strategic actors (from the public and private sectors) in the implementation of the policy, as well as dissemination, training and education in it.

Observations and reflections:

The Metropolitan Guide N°3, for the inclusion of sustainability criteria in the configuration of public and private open spaces, becomes a reference for the design of green infrastructure and open spaces; establishing sustainability criteria for the design of interventions in constitutive and complementary elements of public space and open spaces owned and used privately. These include: Runoff Management through Sustainable Drainage Systems (SUDS). Stability of channels through ecological engineering. Stabilization of slopes through ecological engineering. Which are related to the concept of nature-based solutions proposed by the URBAN GreenUP.

The financial instruments proposed within the framework of strategic lines 2 and 3, although applied as an incentive to promote sustainable urban planning, could become a benchmark for the implementation of NBS in private properties.

The construction of the Policy has made it possible to identify and promote alternative financing instruments for the construction sector, such as green mortgages, which go hand in hand with good construction practices, and include elements of sustainability (for example, from energy and water efficiency). At this point, complementarity can be achieved with nature-based solutions-NBS, especially for those related to vertical and horizontal green infrastructures.

Agreement 23 of 2015 does not establish the bidirectional channels and mechanisms, which allow generating communication between the Metropolitan Area of the Aburrá Valley and the different interest groups, to monitor and verify the effectiveness of the instruments proposed within the framework of the Policy.

It would be important to know the process of monitoring the implementation of the policy, as well as the results of the dissemination, awareness, training and education plan; and the monitoring and evaluation agenda proposed by it. In order to determine active interest groups and results that can contribute to the Renaturalization Plan.

- ***Agreement 019 of 2017 - Management of urban green public space, Metropolitan Green Fund, and replacement by logging***

Objectives and object: Formation of the Metropolitan Green Fund for the generation and administration of new green public space, and the planting and maintenance of urban trees. It enables different tools for the compensation of green public space from a minimum compensation and additional measures.



Actors: Territorial entities (Secretariats of environment, Departments/Secretariat of Planning), Metropolitan Area of the Aburrá Valley, Corantioquia, Police Inspections, Construction Guild, Colombian Chamber of Construction in Antioquia-Camacol, private construction sector.

Mechanisms and instruments: Strengthening of geographic information systems and biannual update of the green public space index. Definition of a cost-benefit model for urban green areas as a whole. Adoption of the economic valuation model of the urban trees of the Aburrá Valley, as a basis for defining the replacement of individuals and the appraisal of additional measures to the replacement; configuring a comprehensive tree replacement plan, yes as for the appraisal of fines in environmental sanctioning processes. Strengthening of Police Inspections and other government bodies to achieve the restitution of green public spaces occupied or transformed into hard floors.

Observations and reflections: A preponderant role of the AMVA is established around the management and operation of the Fund, however, the Decree does not define the specific roles of each of the dependencies in which the technical, legal, administrative and financial functions are assigned, and that would allow the operation of the proposed strategies.

It defines a financial tool that aims at the efficient management of green public space. The ecological value unit provides greater diversity in terms of measures associated with replenishment, to ensure its effectiveness.

It has allowed the identification of potential properties to be incorporated into green public spaces or to guarantee the replacement of green areas and arboreal individuals. To this end, a soil inventory was generated to enable compensation in public areas, as well as an identification of private properties with the capacity to receive the planting of trees (receiving properties of environmental importance).

The Agreement establishes that the Fund will operate with financial resources associated with forest harvesting procedures, fines collected in sanctioning procedures and national and international cooperation. It also determines that the municipalities of the region may allocate resources from urban obligations to nourish this Fund. However, it is ideal to know the details of the operation of the Fund and the difficulties of its implementation. As well as monitoring the specific destinations of urban planning obligations with a view to determining additional financing resources for green space and resources for the implementation of NBS.

- ***Resolutions 218 and 243 of 2011 - Forest harvesting permits and ecological connectivity studies***

Objectives and purpose: The information and technical conditions that must be taken into account by those interested in the granting of forest use permits are defined, in order to prevent and minimize the possible risks and threats that such interventions may introduce into the territory. It also includes relevant information for the technical evaluation of the forest harvesting process, when the intervention of the tree component is located on the withdrawals of water sources.

Actors: Metropolitan Area of the Aburrá Valley (Environmental Subdirectorate), Corantioquia, interested in the granting of forest use permits.



Mechanisms and instruments: The technical and environmental requirements that must be taken into account by those interested in the granting of forest use permits are detailed, and that include, among others: location and description of the project, characterization of the environmental impacts to be generated by the interventions of the tree component, landscape proposal that mitigates the impacts generated on the biotic component (flora and fauna), forest inventory (list of 100% of the existing trees, volume of wood per species resulting from the use), fauna rescue plan, in case the tree intervention affects it.

Observations and reflections: Technical resolution on forest harvesting permits, from which the obligatory nature of the replacement of the cut individuals and the selection of the species to be planted according to their ecological value is established.

No additional mechanisms or instruments are established that contribute to the generation of new green public space.

- **Resolution 2247 of 2018 - Model that establishes unit of ecological value for urban trees**

Objectives and object: Adopt the model that establishes the unit of ecological value - UVE, for urban trees. Model that had its origin in the Master Plan of Urban Green Public Spaces of the metropolitan region of the Aburrá Valley -PMEPVU and whose calculation variables are associated with the diameter to the height of the chest, aptitude of the individual in the green space, and landscape contribution of the species.

Actors: Territorial entities (Secretariats of environment, Departments/Secretariat of Planning), Metropolitan Area of the Aburrá Valley, Corantioquia, Private construction sector, interested in the granting of forest use permits.

Mechanisms and instruments: The resolution adopts the Ecological Value Unit Model and annexes the guide for its implementation. It does not generate mechanisms or instruments for its implementation, in addition to what has already been proposed in Agreement 019 of 2017.

Observations and reflections:

It operates as a model of economic valuation of trees based on intrinsic variables of the individual (diameter, location, landscape contribution) that allows quantifying the externalities that projects cause on them.

Normative articulation around the minimum replacement and the additional measures to the replacement that include: payment of the remaining value after the minimum replacement required according to the application of the model is valued, elimination or extraction of stumps, conversion of hard floors to green soil and recovery of the vegetal cover in the public space, maintenance of juvenile trees, acquisition and delivery of real estate. Although these measures are aimed at the generation of new green public space, a detailed assessment of the real impact on the increase of new metropolitan green space would be relevant.

Complementarity, with what was proposed in Agreement 019 of 2017, around the financial resources delivered by the beneficiaries of forest use procedures and that will allow items for the acquisition of land.

The agreement does not establish monitoring and control mechanisms to measure the effectiveness of the proposed instrument.



- **Resolution 2248 of 2018 - Metropolitan Green Fund and guidelines for its operation**

Objectives and purpose: Metropolitan Green Fund and guidelines for its operation. The object of the fund, the origin and destination of the resources and the direction and administration of the fund are defined.

Actors: Territorial entities (Secretariats of the Environment, Departments/Secretariat of Planning), Metropolitan Area of the Aburrá Valley, interested in the granting of forest use permits, Ministry of Finance.

Mechanisms and instruments: The direction of the Green Fund is established by the AMVA through the dependencies in which the respective technical, legal, administrative and financial functions are assigned.

The activities that the AMVA must carry out to administer the fund are detailed. These include monitoring, approval and budget implementation, accounting and management reporting. It is established that for the execution of resources can be made use of schemes of agreements, public trust and / or fiduciary commission.

Observations and reflections:

The observations included in the revision of Agreement 019 of 2017 apply. Especially the one related to the monitoring of the items coming from urban obligations so that the specific destinations for the generation of green spaces are guaranteed and that the resources are not appropriated only in equipment. Likewise, it is necessary to evaluate the prescription of inter-administrative agreements that allow the collection of resources by the AMVA and its subsequent distribution in the municipalities that make it up.

It is necessary to generate operational or instrumental instruments that allow the efficient management of the special account created by the Ministry of Finance, to finance the acquisition or generation of green public space.

- **Resolution 3677 of 2018 - Additional conditions for forest harvesting procedures**

Objectives and object: Additional conditions for the procedures of forest use advanced before the Metropolitan Area of the Aburrá Valley. It welcomes the terms of reference for the preparation of the Connectivity Study to support the evaluation of environmental procedures that require tree intervention. It defines the protocols for information gathering, driving away, rescue, care, assessment and reintegration of wildlife affected by projects, works or activities with environmental permit or licensing.

Actors: Metropolitan Area of the Aburrá Valley, interested in the granting of forest use permits.

Mechanisms and instruments: The Resolution is developed from four chapters:

Chapter 1: The Permit for the Forestry Use of Isolated Trees is regulated on the occasion of the realization, remodeling or expansion of public or private infrastructure works, constructions, facilities and the like, and the conditions to carry out the procedure before the AMVA are established.



Chapter 2: The ecological networks of the Aburrá Valley are updated and the Terms of Reference for the preparation of the Connectivity Study are accepted to support the evaluation of environmental procedures that require tree intervention within the jurisdiction of the AMVA.

Chapter 3: The Protocols are established for the collection of information, driving away, rescue, care and assessment and reintegration of wild fauna affected by projects, works or activities with environmental permit or licensing and the registration of veterinary centers for the care and assessment of wildlife affected by projects, works or construction activities.

Chapter 4: Regulatory obligations regarding citizen information on applications for tree intervention permits processed before the Metropolitan Area of the Aburrá Valley as an Urban Environmental Authority.

Observations and reflections:

Articulation around the generation of value derived from forest use: the provisions for the application for forest use and the Comprehensive Tree Replacement Plan are linked to what is regulated in Metropolitan Agreement No. 019 of December 27, 2017 and Metropolitan Resolution No. 2247 of 2018.

The result of the Ecological Connectivity study can yield replenishments in green areas outside the property, which could eventually lead to new green public spaces, so it is important to consider it as an instrument for the Renaturalization Plan.

- **Metropolitan Strategic Plan for Territorial Planning – PEMOT (in the approval phase).**

Objectives and purpose: Exercise of territorial planning with systemic and multiscale approach, from which it is intended to harmonize the management plans of the 10 municipalities that make up the AMVA, against strategic issues and general guidelines that include land uses and conservation areas, sustainable mobility, preservation of natural resources and ecosystems, occupation of the territory, residential public services, service networks and metropolitan public space.

This instrument will contribute to the construction of the Territorial Planning System of the Aburrá Valley, based on three fundamental purposes: harmonizing the metropolitan and regional territory, increasing territorial efficiency and promoting the development of society.

Actors involved: Municipal Administrations, Municipal Councils, Environmental Tables and Collectives, Territorial Planning Councils, alternative means of communication, academia, Government of Antioquia, ANDI, Metropolitan Planning Council, management and professional staff of the Metropolitan Area.

Mechanisms and instruments: the PEMOT contemplates the definition of the strategy and the system for the integral management of water. The definition of the metropolitan system of roads and urban public transport. The metropolitan equipment system. The sizing and definition of the strategy for social and priority housing in the metropolitan area and the instruments for land management.

Observations and reflections: The PEMOT will provide strategic elements for the planning of urban green, so it becomes a key input for the Renaturalization Plan. However, to date there are no technical supporting documents that allow an analysis of their implications and



interactions with the renaturalization strategy; and the Metropolitan Agreement that adopts it has not been approved.

6.1.2 Regulation at the regional scale (Corantioquia)

At the regional level, the regulations recognize the existence of protection figures and adopt their management plans, as instruments of superior hierarchy and environmental determinant in the planning of municipalities. They establish the zoning and define the regime of uses of these areas, in order to guarantee their conservation and maintenance. In this sense, the regulations account for two protected areas, one at the national level and the other at the regional level that are part of the EEP of the municipality, as well as the POMCA of the Aburrá River, which should be considered in the formulation of the Renaturalization Plan. This regulation corresponds to:

- Agreement 267 of 2007 -Aburrá Integrated Management District - Río Cauca
- Resolution 1510 of 2010 - Nare Protective Forest Reserve
- Resolution 1811-6712 of 2018 - Management Plan for the Aburrá River Basin
- Resolution 9328 of 2007 - Maximum densities of housing on rural land

As strategic actors of the regulations associated with these protection figures, there are the Ministry of Environment and Sustainable Development, Cornare, Corantioquia, Metropolitan Area of the Aburrá Valley, Municipal Mayors, Secretariats of Environment and Municipal Planning, Universities and Educational Institutions. In the case of POMCA, the aforementioned actors are considered and include: Public Companies of Medellín, Department of Risk and Disaster Prevention, Veredales Aqueduct Boards, JAL, and JAC.

Within the framework of the formulation of the Renaturalization Plan, a detailed analysis of the instruments adopted by regulations will be required, and especially of the zoning proposed in each of them. So that future intervention actions on the territory can be articulated, to the areas of restoration and sustainable use delimited in these instruments; with a view to increasing urban and rural green, from the implementation of NBS, enabling joint objectives of rehabilitation, connectivity and integration of ecosystems and as well as the enhancement of priority ecosystem services at each territorial scale.



Annex 2: Stakeholder workshop proposals for improvements to NBS delivery.

1. Environmental and/or forestry experts
2. Create an annex to the Planning Secretariat, in charge of green planning and monitoring
3. Collection of project information, history, etc.
4. There should be a team that evaluates city projects from the green.
5. Green management policies on site
6. The actions, activities, and other processes of green infrastructure should not be separated into different dependencies. It must be activated as a whole, to avoid difficulties and generate a good joint.
7. Socialization of green infrastructure within the entire organization.
8. Greater territorial control that allows the preservation of the territory.
9. Articulated, managerial and technical work for the consolidation and strengthening, as well as the complement, of elements of the ecological structure (e.g. ecological network) for the consolidation of green elements.
10. Knowledge and appropriation, as well as suggestions resulting from the provisions of the POT for proper implementation in the territory and consequent environmental improvement.
11. Improvement of SIGAM and its CTIs
12. Strengthen funding.
13. Link qualified specialized personnel.
14. Strengthening of green infrastructure planning and ecological structure in all institutions.
15. Inter-institutional coordination and communication through SIGAM.
16. Work comprehensively on all renaturalization issues
17. Work articulately
18. Assess the impacts of the measures taken
19. Integrate renaturalization into climate change mitigation and adaptation plans
20. Greater articulation between entities with common objectives and goals.
21. Incorporate planning within the functions of the SMA according to the dec. 883 of 2015
22. Feedback on what each agency does, plans, proposes, etc.
23. Centralize the governance of green infrastructure and EE in a single unit within the Mayor's Office (SMA), which gives specific guidelines for green.
24. Management of greater economic resources by undersecretaries and program heads, prioritizing and making viable programs and projects.
25. Increase human resources to ensure green management
26. Establish an Inter-institutional committee for the management of the recovery and restitution of green where they determine the actions of each agency or entity when it is necessary to undertake immediate tasks "risk".
27. Clear guidelines that allow us to carry out activities in the same way and generate traceability of the information.
28. Accessibility to information
29. Generate awareness among the officials of the Mayor's Office of Medellín so that the importance of green infrastructure and ecological structure in the city is understood, generate spaces to publicize the projects and actions associated with the latter. This



- generates synergies and each server feels involved and responsible as a citizen and as an official.
30. Strengthening of the work instances to achieve the articulation of the green component of the projects
 31. Development of work plans that include all units
 32. Pool of resources for green interventions with contributions from each agency
 33. Awareness of green to engineers.
 34. Elaboration of a comprehensive plan of the green component that directs all the actors involved.
 35. Define a team in charge of monitoring and follow-up of the Plan
 36. Define an education strategy around the green component that helps sustainability
 37. That the entire green component is channeled by a single entity (SMA)
 38. There are many problems of inter- and intra-institutional disarticulation, which means that the protection of green and protective soils is not carried out as it should be.
 39. There must be more work to raise awareness among the community, recognizing them as actors in the management of green and overseers of the main ecological structure.
 40. In interactions with environmental authorities, it is necessary to "clarify" processes and unify requests for information that are all aimed at the same objective, the management of the urban and rural green component.
 41. With the administrative units it is necessary to improve the flow of information, because both the administration and Epm have the commitment of responsibility with the green component, but for this it is necessary to know what each one is doing.
 42. Openly share databases with information corresponding to the management of the green component.
 43. The management of the green is carried out by several dependencies and entities that in many cases do things differently and handle the information in a "local" way. To improve the governance of the green infrastructure, a solution can be to create or define a single entity that carries out all the management or give the management lines and where all the information converges for the making of better decisions.



Appendix 3: Interview and details of the successful 30 Green Corridors Project

1. Who have been the main participants involved in this work? Can you describe your roles?

The Mayor's Office of Medellín has been intervening 30 Green Corridors: eighteen (18) associated with mobility intervened by the Secretariat of Physical Infrastructure and twelve (12) associated with withdrawals of streams intervened by the Ministry of the Environment.

The corridors corresponding to the Secretariat of Physical Infrastructure:

Secretary of Physical Infrastructure: *Paula Andrea Palalacio Salazar*

Undersecretary of Planning: *Silvia Elena Gómez García*

Undersecretary of Construction and Maintenance: *Andrés Felipe Uribe Zapata*

University Professional (Civil Engineer), project supervisor: *Carolina Pabón Muñoz*

University Professional (Environmental Engineer), project supervisor: *Lina María Vanegas González*

Team of the Strategic Urban Projects Management, made up of:

Director: Doctor Architect Engineer *Alejandro Restrepo Montoya*.

Coordinator: *Carolina Londoño*.

Professional: Bioclimatic *Alexander González*.

Professional: Forest Engineer *Mauricio Jaramillo Vásquez*.

Professional: Landscape Architect *Nicolás Hermelin Bravo*.

Professional: Architect Designer *Edgar Mazo Zapata*.

Professional: Architect Designer *Sebastián Mejía Alvarez*.

Professional Architect: *Sebastián Ramirez, Camila Katich, Diana González, Lina Upegui Lopera*.

The corridors corresponding to the Ministry of environment are in charge of the Undersecretariat of Natural Resources - Ecological Structure Unit who have participated during the formulation, initiation and development. This team is made up of:

Secretary of the Environment: *Sergio Andrés Orozco Escobar*

Undersecretary of Natural Resources: *Javier Eduardo Posada Muñoz*

Program Leader: *Jaime Alberto Gómez Cuervo*.

Professional: Landscape Architect *Marcela Noreña Restrepo*.

Professional: Forestry Engineer *Ana María Villa Grajales*.

Professional: Forestry Engineer *Fabio Saldarriaga*

Professional: Architect *David Andrés Mejía Gómez*.

The professional supervisors, officials assigned to the Ministry of the Environment are the ones who monitor the contractor who develops the project, and it is the latter, the one in charge of hiring the professional staff and labor for its fulfillment. Within the project were hired by the operator Botanical Garden seven (7) professional Forest engineers four (4) Technicians and 18 gardeners.



2. Can you give examples of the types of trees and vegetation that have been planted and the reasons why they were selected? He mentioned 96,000 "minor species" planted on Avenida Oriental. What kind of species are they?

Species have been planted that generate shelter, serve as perch, rest and food for fauna such as guava (*Psidium guajava*), Guamo (*Inga herreriae*), ariza (*Brownea ariza*), among others. Species that help reduce the temperature by their large porte such as Green Ceiba (*Pseudobombax septenatum*), Ebano (*Caesalpinia ebony*), Chiminango (*Pithecellobium dulce*), Caracolí (*Anacardium excelsum*).

The improvement of the landscape with the multistratification, naturalization and enrichment of the landscape, in which each individual makes his contribution. In addition to the selection criteria, the supply of plant material existing in the nurseries is also taken into account, which are species that belong to the American tropics and that have successful experiences of adaptability to the ecological conditions of Medellín, which is located in the Premontane Humid Forests life zone (Holdrige Life Zone Classification System). Additionally, it was taken into account that the material to be acquired outside nurseries with certification of the quality of plant material.

The following table presents the tree species that were planted in the Avenida Oriental corridor and their size or level of growth (high, medium and low):

| No. | Common name | Scientific name | Size |
|-----|-----------------------|---------------------------------|--------|
| 1 | Cow Helmet | <i>Bauhinia picta</i> | Middle |
| 2 | Arizá | <i>Brownea ariza</i> | Middle |
| 3 | Pandurata | <i>Ficus lyrata</i> | Middle |
| 4 | Yellow Acacia | <i>Caesalpinia pluviosa</i> | Middle |
| 5 | Aguacatillo | <i>Persea caerulea</i> | High |
| 6 | Black Olive Tree | <i>Bucida buceras</i> | High |
| 7 | Soap maker from China | <i>Bipinnate Koelreuteria</i> | Low |
| 8 | Zancona Palm | <i>Syagrus sancona</i> | High |
| 9 | Guamo | <i>Inga herreriae</i> | Middle |
| 10 | Neem | <i>Azadirachta indica</i> | Middle |
| 11 | Saman | <i>Samanea saman</i> | High |
| 12 | Ebony | <i>Caesalpinia ebano</i> | High |
| 13 | Washingtonian Palm | <i>Washingtonia robusta</i> | High |
| 14 | Royal Palm | <i>Roystonea regia</i> | High |
| 15 | Jacaré | <i>Chloroleucon aff. Tortum</i> | High |
| 16 | Chiminango | <i>Pithecellobium sweet</i> | High |
| 17 | Choibá | <i>Dipteryx oleifera</i> | High |



| | | | |
|----|------------------------------------|-----------------------------------|--------|
| 18 | Almond | <i>Terminalia catappa</i> | Middle |
| 19 | Guayacan Yellow | <i>Tabebuia chrysantha</i> | Middle |
| 20 | Jaboticaba | <i>Myrciaria cauliflora</i> | Low |
| 21 | Guayacan de Bola | <i>Bulnesia arborea</i> | High |
| 22 | Biscofia | <i>Javanic bischofia</i> | Middle |
| 23 | Guayacan Purple | <i>Tabebuia rosea</i> | Middle |
| 24 | Caracolí | <i>Anacardium excelsum</i> | High |
| 25 | Vara Santa | <i>Triplaris americana</i> | Middle |
| 26 | Cedar | <i>Cedrela Odorata</i> | High |
| 27 | Seven Leathers | <i>Machaerium capote</i> | Low |
| 28 | Mahogany Camb | <i>Erythrina poeppigiana</i> | High |
| 29 | Gualanday | <i>Jacaranda mimosifolia</i> | High |
| 30 | Green Ceiba | <i>Pseudobombax septenatum</i> | High |
| 31 | Fox Saithe | <i>Cojoba arborea</i> | Middle |
| 32 | Cassia Grandis | <i>Cassia grandis</i> | Middle |
| 33 | Alligator Ioin | <i>Platypodium elegans</i> | High |
| 34 | Forever | <i>Pithecellobium</i> | High |
| 35 | Caimo | <i>Pouteria sp.</i> | Middle |
| 36 | Guava | <i>Psidium guajava</i> | Low |
| 37 | Governor's Cherry Tree | <i>Adenantha pavonina</i> | Low |
| 38 | Sugar Palm | <i>Syngus romanzoffiana</i> | Middle |
| 39 | Cannonball | <i>Couropita guianensis</i> | Middle |
| 40 | Balsam | <i>Myroxylon balsamum</i> | Middle |
| 41 | Red brush | <i>Callistemon speciosus</i> | Low |
| 42 | Catape, Cobalongo | <i>Catape, Cobalongo</i> | Low |
| 43 | Pink ceiba | <i>Ceiba speciosa</i> | Middle |
| 44 | Cheflera | <i>Schefflera actinophylla</i> | Middle |
| 45 | Cork, White Calistemo | <i>Melaleuca quinquenervia</i> | Middle |
| 46 | curarí, Flor amarilla or curarire. | <i>Handroanthus serratifolius</i> | Middle |
| 47 | Queen's Flower | <i>Lagerstroemia speciosa</i> | Middle |
| 48 | Frámire | <i>Terminalia ivorensis</i> | High |



| | | | |
|----|--------------------------------------|---------------------------------------|----------|
| 49 | Yellow Guayacan, Chicalá | <i>Handroanthus chrysanthus</i> | Middle |
| 50 | Furry Guayacan | <i>Tabebuia chrysotricha</i> | Low |
| 51 | Guayacan clover | <i>Platymiscium pinnatum</i> | Low |
| 52 | Naked Indian | <i>Bursera simaruba</i> | Middle |
| 53 | Jobo | <i>Spondias mombin</i> | Low |
| 54 | Laurel | <i>Lilys triandra</i> | Middle |
| 55 | Laurel, False Laurel, Rubber | <i>Ficus benjamina</i> | High |
| 56 | Cleaners, Diospiro | <i>Diospyros nigra</i> | Middle |
| 57 | Parrot, Iguano, Harino | <i>Costa Rican Dilodendron</i> | High |
| 58 | Majagua | <i>Talipariti elatum</i> | High |
| 59 | Mamoncillo, Mammon | <i>Melicoccus bijugatus</i> | High |
| 60 | Mango | <i>Mangifera indica</i> | Middle |
| 61 | Orange | <i>Citrus maxima</i> | Low |
| 62 | Ochuvo | <i>Duranta erecta</i> | Low |
| 63 | Coconut palm | <i>Cocos nucifera</i> | Stocking |
| 64 | Palma Manila | <i>Adonidia merrillii</i> | Casualty |
| 65 | Payanesa palm | <i>Archontophoenix cunninghamiana</i> | Middle |
| 66 | Robeleni palm | <i>Phoenix roebelenii</i> | Casualty |
| 67 | Sail pine | <i>Cupressus sempervirens</i> | Middle |
| 68 | Plumeria | <i>Plumeria pudica</i> | Low |
| 69 | Elder | <i>Viburnum sp</i> | Low |
| 70 | Trompillo, Male cedar, Cartagüeño | <i>Guarea guidonia</i> | Middle |
| 71 | Trúntago | <i>Vitex sp</i> | Middle |
| 72 | African Tulip, Miona | <i>Spathodea campanulata</i> | Middle |

Table 6.1: Tree species planted in Avenida Oriental corridor

In the corridor of Avenida Oriental, 96,000 plants (individuals) corresponding to "minor species" that are shrubs were planted:

| No. | Common name | Scientific name | Total planting area Central separator m ² |
|-----|-------------|---------------------------|---|
| 1 | Shot | <i>Monstera deliciosa</i> | 2324 |



| | | | |
|----|-----------------------------|-----------------------------------|-------|
| 2 | Filodrendo Verde | <i>Philodendron sp.</i> | 3486 |
| 3 | Red Ginger | <i>Alpinia purpurata</i> | 2324 |
| 4 | Heliconia Mini (Choconiana) | <i>Heliconia stricta</i> | 4648 |
| 5 | Ivy | <i>Hedera helix</i> | 6972 |
| 6 | African Iris | <i>Diets Iridioides</i> | 20917 |
| 7 | Lemongrass | <i>Cymbopogon citratus</i> | 3486 |
| 8 | Singonium | <i>Syngonium podophyllum</i> | 5229 |
| 9 | Tango | <i>Lantana camera</i> | 5423 |
| 10 | Verbena | <i>Stachytarpheta cayennensis</i> | 8134 |

Table 6.2: "Minor species" planted in Avenida Oriental corridor

3. **What percentage of the entire "30 Green Corridors" project is complete? When is its conclusion planned? He mentioned that 100% of the central corridor of Avenida Oriental is complete, that there has been 15% progress in the lateral zones, and that the completion is planned for May 2019. Are they on track to meet this deadline?**

Below, the table with the progress of each of the corridors is presented, according to the programming of the project these must be completed in their entirety by November 2019:

| Corridors located in ravines (Name of the ravine) | | Percentage of progress |
|--|---------------|------------------------|
| 1 | Iguana | 100% |
| 2 | Guayabala | 100% |
| 3 | Ana Diaz | 100% |
| 4 | The Bone | 90% |
| 5 | Malpaso | 100% |
| 6 | The Populated | 100% |
| 7 | The President | 100% |
| 8 | Saint Helena | 100% |
| 9 | The Mill | 90% |
| 10 | Altavista | 100% |
| 11 | Bermejala | 100% |
| 12 | Pelahueso | 100% |



Table 6.3: Progress of each corridor located in ravines

| Corridors located on tracks | | |
|-----------------------------|--------------------------------|---|
| Intervened routes | | Percentage of progress |
| 1 | Av. Oriental Central Separator | 100% |
| | Av. Oriental Lateral | 60% (completion March 2019) |
| 2 | Av. Poblado (San Diego) | 100% |
| 3 | Av. Ferrocarril | 100% |
| 4 | Av. Guayabal - Stage 1 | 100% |
| | Av. Guayabal - Stage 2 | 90% |
| 5 | Argentina | 100% |
| 6 | Juan del Corral | 100% |
| 7 | Bones | 100% |
| 8 | 10th Street | 100% |
| 9 | 30th Street | 100% |
| 10 | Race 65 | 30% (full design) |
| 11 | San Juan Avenue | 30% (full design) |
| 12 | Av. Colombia | 30% (full design)) |
| 13 | Av. Poblado | 0% |
| 14 | 33rd Street | 30% (full design) |
| 15 | 29th Street | 10% (inventoried) |
| 16 | Plaza Mayor | 10% (inventoried) |
| 17 | Race 74 | 30% (full design) |
| 18 | Garden Avenue | 30% (full design) completion October 2019 |

Table 6.4: Progress of each corridor located on tracks

4. Set the approximate-planted total area in square meters or hectares. He mentioned that Avenida Oriental has received 2.3 km of vegetation. What is the total length in combination of all runners?

Below is the table with the approximate area of each of the corridors:

| Corridors located in ravines | | |
|------------------------------|--------------------|-----------------------------------|
| No. | Stream | Intervened Area [m ²] |
| 1 | Quebrada Pelahueso | 30,586 |
| 2 | Quebrada La Hueso | 130,545 |
| 3 | Quebrada La Iguaná | 126,807 |



| | | |
|-------|------------------------|---------|
| 4 | Altavista Creek | 58,103 |
| 5 | Quebrada Ana Díaz | 69,579 |
| 6 | Quebrada la Malpaso | 12,198 |
| 7 | Quebrada El Molino | 19,730 |
| 8 | Quebrada La Guayabala | 63,384 |
| 9 | Quebrada La Bermejala | 9,821 |
| 10 | Quebrada La Presidente | 34,577 |
| 11 | Quebrada La Poblada | 12,639 |
| 12 | Quebrada Santa Elena | 31,536 |
| Total | | 599,505 |

Table 6.5: Approximate area of each corridor located in ravines

| Corridors located on tracks | | |
|-----------------------------|--------------------------------|------------------------|
| Intervened routes | | Area [m ²] |
| 1 | Av. Oriental Central Separator | 7,747 |
| | Av. Oriental Lateral | 800 |
| 2 | Av. Poblado (San Diego) | 1,722 |
| 3 | Av. Ferrocarril | 3,361 |
| 4 | Av. Guayabal - Stage 1 | 2,040 |
| | Av. Guayabal - Stage 2 | 8,958 |
| 5 | Argentina | 541 |
| 6 | Juan del Corral | 362 |
| 7 | Bones | 312 |
| 8 | 10th Street | 1,466 |
| 9 | 30th Street | 3,240 |
| 10 | Race 65 | 1,575 |
| 11 | San Juan Avenue | 6,498 |
| 12 | Av. Colombia | 4,869 |
| 13 | Av. Poblado | 4,000 |
| 14 | 33rd Street | 2,750 |
| 15 | 29th Street | 996 |
| 16 | Plaza Mayor | 2,900 (Approx.) |
| 17 | Race 74 | 760 (Approx.) |
| 18 | Garden Avenue | 1,420 (Approx.) |



| | |
|-------|--------|
| Total | 56,137 |
|-------|--------|

Table 6.6: Approximate area of each corridor located on tracks

5. What percentage of Medellín is green space? To what extent has it increased as a result of the project?

At the moment the Municipality of Medellín does not have the updated inventory of green areas for its entire urban area, however, according to the Master Plan of Green Public Spaces made by the Metropolitan Area of the Aburra Valley in 2006, it is established that for the urban area of the Municipality of Medellín there is 18.9% of green public space. However, the Ministry of the Environment carried out in 2016 the "Pilot Project for the Ecological Connectivity of the Urban Green Corridors of the Municipality of Medellín - Phase 1", in which the analysis and study was carried out for 25% of the entire urban area of Medellín, corresponding to 2,955ha, finding as effective green areas a total of 48,351 polygons of green areas, totaling 828.68 ha, which corresponds to 27% of the total study area.

Given that with the Green Corridors associated with streams the interventions have corresponded to the planting of trees, shrubs and palms, in this type of corridors there has been no increase in green space, but an enrichment and improvement of the conditions of the green areas has been carried out. The increase in green spaces has been generated with the green corridors associated with the roads, with which it has been possible to convert 20,808 m² from hard floor to soft floor.

| Hard area converted to green area through the Corridors on tracks | | |
|---|--------------------------------|------------------------|
| Intervened routes | | Area [m ²] |
| 1 | Av. Oriental Central Separator | 7,747 |
| | Av. Oriental Lateral | 800 |
| 5 | Argentina | 541 |
| 6 | Juan del Corral | 362 |
| 7 | Bones | 312 |
| 8 | 10th Street | 1,466 |
| 11 | San Juan Avenue | 2,500 |
| 12 | Av. Colombia | 2,000 |
| 16 | Plaza Mayor | 2,900 (Approx.) |
| 17 | Race 74 | 760 (Approx.) |
| 18 | Garden Avenue | 1,420 (Approx.) |
| Total | | 20,808 |



Table 6.7: Hard areas converted to green areas

While the 20,808 m² that have become the city centre is a low figure, it is really significant, considering that the total green areas this area has around 24,000 m² mainly located in the parks inside the centre of Medellín.

This project is a commitment to the greening of the city, improving the spaces that allow to start with a Public Policy to continue over time and increase the index of green space for the city and positively impact the environment.

6. **How is the impact of green corridors currently being monitored?**

So far, weekly or biweekly visits are made to the corridors to observe the growth, performance and stability of the plantings carried out; as well as the social acceptance of them. As this project is so recent, studies have not yet been established to monitor the impact, however, in the future it is considered its realization.

During the visits, the need for plant replacement, the need for irrigation for the establishment of newly planted plants is studied and a baseline of insects and avifauna has been established.

7. **We are especially interested in the cooling benefits of your work. He mentioned anecdotal evidence about a 2-degree reduction in ambient temperature as a result of the project. How has it been achieved and measured? Are there other initiatives in Medellín that can contribute to the cooling effect? For example, cold surfaces and rooftops? Does the city have a future plan to cope with rising temperatures?**

The reduction of temperature by shade of arborization and control of albedo with vegetal surfaces, in public space of the tropics is not anecdotal, it is real, due to the thermal exchanges that occur between the direct solar phenomenon, the accumulation of heat on stone surfaces and its reflectivity, added to the interaction with the air directly in contact with these surfaces. This condition of radiation and surfaces generates the phenomenon of heat island, which in the case of the centre of Medellín is estimated as +6° above the average temperatures by natural geographical conditions, that is, temperature ranges that oscillate between 24°C and 38°C.

The effect of urban shade and vegetation cover has presented a punctual decrease in surface temperatures and thermal sensation that oscillates between 2°C and 3°C on interventions where vegetation has been consolidated and improved the performance of existing trees, while progressively growing new individuals. The bioclimatic design of these corridors has computer-simulated radiation analysis models, based on performance studies of about 30 species of trees typical of Medellín's climate. The partial performance of these interventions is verified by means of temperature sensors and an infrared camera that records radiant surface temperatures. Reference is made to partial performance because the plantings of arborization species are still to develop their heights and maturity cups, so the phenomenon of temperature reduction can increase over time and the consolidation of vegetation.

Below are the thermal images that allow to evidence the temperature differences between shaded areas with areas exposed to radiation, as well as the difference in reflectivity between stone surfaces and natural textures:





Figure 6.1: San Juan Corridor. Before the green corridor. It shows an urban corridor area that will be intervened as a green corridor.



Figure 6.2: San Juan Corridor. After the green corridor. Decreases in radiant heat between 6°C and 8°C are shown at noon.



Figure 6.3: Argentine Corridor.



Figure 6.4: Oriental Avenue Corridor with intersection with Caracas Street

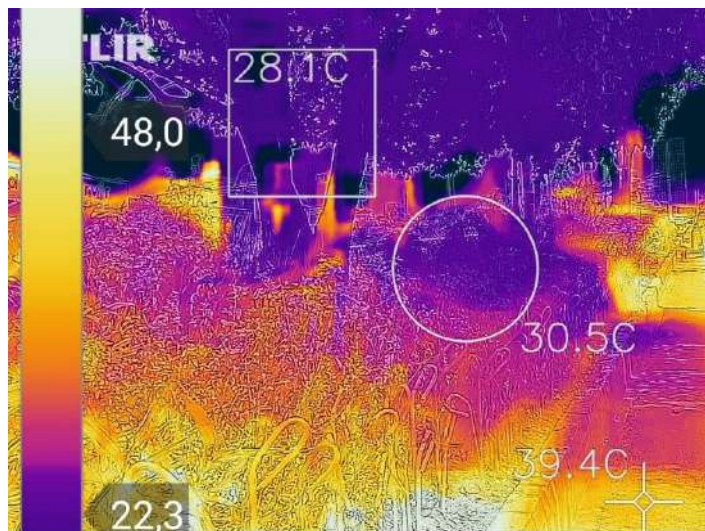


Figure 6.5: Oriental Avenue Corridor with junction with the bridge between San Juan and Los Huesos

There is no general heat island control plan in the city of Medellin that involves buildings beyond some particular green wall and roof initiatives. However, the intervention on parks and green corridors is promoted as a pioneering intervention in the environmental challenge of improving urban habitability by reducing the heat island, along with sustainable mobility strategies such as electric public transport vehicles to improve air quality.

Could you explain in greater detail how this project joins with broader sustainability efforts in Medellin?

From the environmental point of view, the project has a very important component, since it improves air quality, as there is an increase in carbon capture, retention of particulate matter, improvement of the landscape, among others, which leads to greater comfort of users in public space, in the future it is expected to obtain the reduction of air conditioning systems along the road corridors, as a result of the decrease in temperature.

Another benefit that is obtained is the improvement in citizen behavior by presenting greater comfort and habitability in public space. Likewise, a social benefit is generated by the generation of employment that the project generates over time, this is important since it is aimed at people of low economic level, representing for these people a substantial improvement in their quality of life.

At the economic level, the project is involved within the plant material production chain, which encourages the demand for products and inputs for the maintenance and maintenance of the Green Corridors.

Could you tell us about other benefits not related to cooling, such as improving air quality, increasing biodiversity, improving pedestrian pathways, quality of life, etc.? What evidence do you have on these aspects? How do you currently quantify the environmental services provided by these corridors?

There are a variety of ecosystem services that green corridors can provide. Understanding that ecosystem services are defined as the conditions and processes by which ecosystems, and the species that inhabit them, maintain human life. These are classified into 4 broad categories: support, provision, cultural and regulatory.

Among the services provided by a green corridor are considered:

- **Support services:** provision of habitat for species and maintenance of biodiversity, nutrient cycling (feeding for some species)
- **Regulation service:** climate regulation (see answer question 7), air quality regulation.
- **Cultural services:** understood as the non-material benefits obtained from ecosystems through spiritual enrichment, physical beauty, artistic and intellectual inspiration, cognitive development, reflection, creation and aesthetic experiences.

8. How is the project maintained? He mentioned hiring specialized gardeners. How will you ensure that vegetation survives and thrives for the future?

To achieve the maintenance of the project, it has been linked to the Botanical Garden of Medellín – Joaquín Antonio Uribe, which actively participates in the process of landscape beautification of different public spaces of the city; formed by an interdisciplinary team that combines the experience of biologists, forestry engineers, environmental engineers, landscape architects and agronomists, accompanied by gardeners and experienced operators, competent to carry out an integral management of the landscape and floristic component of the proposals related to public space. This accompaniment has been carried out since 2011. The result of this is the good condition of the sites intervened so far.

This type of contracting has allowed the Botanical Garden of Medellín to be custodian of the gardens, vegetable covers, epiphytic plants, trees, shrubs and palms, the maintenance and improvement of the quality of the established is guaranteed, involving in turn an increase in floristic diversity in the city.

The experience of the Botanical Garden of Medellín allows to have little by little a global and experienced knowledge of the vegetation, ensuring that the plant component is



intervened in an appropriate way, being participants in the planning policies of the arborization in the region.

In addition, a social accompaniment is carried out, in which a work of appropriation and awareness is constantly being done that seeks that the community understands its fundamental role in the sustainability of the Corridors.

For this we work from 4 approaches:

- **Appropriation and social mobilization:** Encourage citizen appropriation of spaces of community interrelation, strengthening collective leadership through communicational work between the community and institutions, promoting the good use, care and appropriation of public space.
- **Participation information:** Through social accompaniment it is intended to promote citizen participation through the exercise of surveillance and community control for the proper development of the work, channeling concerns, doubts, annoyances and proposals of the population to make them participate in the solution.
- **Dissemination:** Disseminate the project for citizens, in order to strengthen its projection, as a replicable model of intervention, recognition and assessment of its objective.
- **Citizen training and training:** Educate the community through training and practical playful education about the importance of their participation in the care and protection of the works
- **Transversal activities:** Interact with the different public and private entities for social participation, support and valuation of the Green Corridors project through educational, cultural and artistic activities that promote environmental development in the city.

Expert (specialized) gardeners come from all over the city, at the moment the botanical garden of Medellín has around 300 gardeners doing forestry activities in the green areas of all the communes of Medellín. Many of them are from rural areas, peasants, coffee pickers and for different circumstances migrated to the city. Some of the gardeners have the labor certification of the SENA where they accredit being gardeners with technical criteria and at all times they are being trained in the field and feedbacks in the knowledge of gardening.

Although you cannot ensure 100% that the vegetation survives, you can have the peace of mind that the species sown were previously selected according to their adaptability to the conditions of the city, also hiring specialized gardeners guarantees the treatment that should be given to the plants in terms of pruning, phytosanitary control, fertilization, control of arvenses, irrigation among others. Additionally, periodic visits are made throughout all corridors to identify needs for replanting or restitution of plants, trees, shrubs, palms and soil, and suggest practices for their correction.

9. **Can you tell us more about how you have involved the community in the design/implementation of this initiative? In particular, how have you engaged poorer neighborhoods to ensure that benefits are distributed equitably?**

At the time of execution, the contractor is the one who can receive the resumes of the people who are interested in intervening in the execution of the project. Prior to the



start of the work, socializations are carried out so that anyone who wishes to participate in the execution applies.

The operator botanical garden of Medellín "Joaquín Antonio Uribe", has some methods and procedures for the selection of personnel, which can be accessed by people of low economic level.

10. He mentioned that the project is 100% funded by the government. What role does the ACI play in attracting private funding to this project?

The Agency for Cooperation and Investment of Medellín and the Metropolitan Area – ACI Medellín is an association of public entities: Alcaldía de Medellín, EPM, Área Metropolitana del Valle de Aburrá and EMVARIAS.

Since its creation in 2002, it has established itself as a key player in the internationalization process for the development of the territory through the construction of strategic international relations, facilitating access to the city and the region of international cooperation resources and the arrival of national and foreign investment.

On its cooperation management front, it is responsible for seeking technical or financial resources to leverage the programs prioritized by the City Government Plan, by applying these good practices to calls for cooperation among which are: subsidies, awards, management in international networks of cities, etc.

Similarly, Medellín has understood that it is necessary not only to demand cooperation, but it is important to offer cooperation, in this case technical, so we constantly receive the visit of delegations of local and international governments interested in knowing the good practices and lessons learned in different topics, in this case the Green Corridors project is an experience that we are currently making visible before the eyes of the world for its direct impact on the social, urban and environmental development of Medellín.

11. Do you plan to further expand green spaces in the city? And if so, in what way, and how will they be financed?

The present administration invested resources for the greening of the city through this project and others; and it is proposed that this project and others related to the improvement of air quality be a Public Policy, which implies that there is a budget in each administration for its execution and maintenance, since due to the particular conditions of Medellín, in which there are two periods a year where critical levels of pollution are presented, these actions must continue to be carried out with the aim of contributing to the improvement of air quality and as a consequence to the improvement of the health of citizens.



Annex 4: Distribution of neighbourhood ranges for each commune

| COMMUNE | Number of neighbourhoods in <i>subreto</i> sum average ranges per commune | | | | | | Total neighbourhoods |
|------------------------------------|---|------|-----|-----|-----|-----|----------------------|
| | 1 | | 2 | | 3 | | |
| | # | % | # | % | # | % | |
| Manrique | | 0% | 2 | 11% | 17 | 89% | 19 |
| San Javier | | 0% | 1 | 11% | 8 | 89% | 9 |
| Popular | 1 | 5% | 2 | 9% | 19 | 86% | 22 |
| Twelfth of October | | 0% | 3 | 25% | 9 | 75% | 12 |
| La Candelaria | 1 | 6% | 4 | 25% | 11 | 69% | 16 |
| Santa Cruz | | 0% | 4 | 33% | 8 | 67% | 12 |
| Aranjuez | 3 | 18% | 3 | 18% | 11 | 65% | 17 |
| The America | | 0% | 5 | 36% | 9 | 64% | 14 |
| Castile | 1 | 5% | 7 | 33% | 13 | 62% | 21 |
| Laureles Stadium | 1 | 4% | 11 | 42% | 14 | 54% | 26 |
| Oak wood | | 0% | 13 | 46% | 15 | 54% | 28 |
| Beautiful Villa | 3 | 13% | 12 | 50% | 9 | 38% | 24 |
| Buenos Aires | 4 | 20% | 11 | 55% | 5 | 25% | 20 |
| The Village | 3 | 15% | 14 | 70% | 3 | 15% | 20 |
| Bethlehem | 9 | 35% | 14 | 54% | 3 | 12% | 26 |
| Corr. of Altavista | 5 | 100% | | 0% | | 0% | 5 |
| Corr. of San Antonio de Prado | 4 | 67% | 2 | 33% | | 0% | 6 |
| Corr. of San Cristóbal | 8 | 89% | 1 | 11% | | 0% | 9 |
| Corr. of San Sebastián de Palmitas | 15 | 100% | | 0% | | 0% | 15 |
| Corr. of Santa Elena | 8 | 100% | | 0% | | 0% | 8 |
| Total neighbourhoods in each range | 66 | 20% | 109 | 33% | 154 | 47% | 329 |

Table 6.8: Average and over-position ranges of challenges and *subretos* for neighbourhoods of Medellín

| COMMUNE | QUARTER | Prom. Subreto Sum | Prom range. Subreto Sum | Prom. Sum Challenge | Prom range. Sum Challenge |
|--------------------|-----------------------|-------------------|-------------------------|---------------------|---------------------------|
| San Javier | The Independences | 11,7 | 3 | 4,5 | 3 |
| Oak wood | Blanquizal | 11,4 | 3 | 4,5 | 3 |
| Twelfth of October | Mirador del Doce | 11,3 | 3 | 4,2 | 3 |
| Aranjuez | Moravia | 11,0 | 3 | 4,2 | 3 |
| La Candelaria | La Candelaria | 11,0 | 3 | 3,3 | 3 |
| La Candelaria | Guayaquil | 10,9 | 3 | 3,3 | 3 |
| La Candelaria | Nutibara Hill | 10,9 | 3 | 3,1 | 3 |
| Laureles Stadium | The America | 10,9 | 3 | 3,4 | 3 |
| Buenos Aires | Bomboná No.1 | 10,9 | 3 | 3,8 | 3 |
| Manrique | Manrique Central No.1 | 10,8 | 3 | 3,6 | 3 |
| Manrique | Manrique Central No.2 | 10,8 | 3 | 3,6 | 3 |
| Popular | Hope No.2 | 10,8 | 3 | 4,0 | 3 |
| Castile | Hope | 10,7 | 3 | 3,6 | 3 |
| Castile | Progress | 10,7 | 3 | 3,9 | 3 |
| Popular | The Commitment | 10,7 | 3 | 4,0 | 3 |
| Twelfth of October | San Martin de Porres | 10,7 | 3 | 3,5 | 3 |
| Castile | Kennedy | 10,7 | 3 | 3,5 | 3 |
| Laureles Stadium | Lorraine | 10,6 | 3 | 3,2 | 3 |
| Oak wood | Beautiful Horizon | 10,5 | 3 | 3,6 | 3 |
| The America | The Prairie | 10,5 | 3 | 3,4 | 3 |
| Aranjuez | San Pedro | 10,5 | 3 | 3,6 | 3 |
| Twelfth of October | The Diamond | 10,5 | 3 | 3,5 | 3 |
| La Candelaria | Colon Neighborhood | 10,4 | 3 | 3,6 | 3 |
| Twelfth of October | Peak | 10,4 | 3 | 3,4 | 3 |
| Oak wood | The Manger | 10,3 | 3 | 3,8 | 3 |
| Aranjuez | Brasilia | 10,3 | 3 | 3,4 | 3 |



| | | | | | |
|--------------------|------------------------------|------|---|-----|---|
| The America | Cristobal Neighborhood | 10,3 | 3 | 3,3 | 3 |
| Popular | Paul VI Village | 10,3 | 3 | 3,8 | 3 |
| Santa Cruz | Villa Nice | 10,2 | 3 | 3,7 | 3 |
| Aranjuez | Miranda | 10,2 | 3 | 3,6 | 3 |
| San Javier | New Conquerors | 10,2 | 3 | 3,7 | 3 |
| Aranjuez | Seville | 10,2 | 3 | 3,8 | 3 |
| Oak wood | Clear Source | 10,2 | 3 | 3,8 | 3 |
| Buenos Aires | Buenos Aires | 10,2 | 3 | 3,6 | 3 |
| San Javier | John XXIII Bankruptcy | 10,2 | 3 | 3,4 | 3 |
| La Candelaria | New Villa | 10,2 | 3 | 3,2 | 3 |
| Popular | Santo Domingo Savio No.1 | 10,2 | 3 | 3,6 | 3 |
| Aranjuez | Bermejal-Los Alamos | 10,2 | 3 | 3,6 | 3 |
| Twelfth of October | Twelfth of October No.2 | 10,2 | 3 | 3,4 | 3 |
| Laureles Stadium | Simon Bolivar | 10,1 | 3 | 3,1 | 3 |
| Aranjuez | Jesus Nazarene | 10,1 | 3 | 3,7 | 3 |
| Bethlehem | Bethlehem | 10,1 | 3 | 3,4 | 3 |
| Santa Cruz | Santa Cruz | 10,1 | 3 | 3,5 | 3 |
| The America | San Javier No.2 | 10,1 | 3 | 3,4 | 3 |
| Beautiful Villa | Caycedo Neighborhood | 10,0 | 3 | 4,0 | 3 |
| Beautiful Villa | Thirteenth of November | 10,0 | 3 | 4,2 | 3 |
| Castile | Alfonso Lopez | 10,0 | 3 | 3,4 | 3 |
| Santa Cruz | The Rose | 10,0 | 3 | 3,3 | 3 |
| Twelfth of October | Picachito | 10,0 | 3 | 3,4 | 3 |
| The America | The Danube | 10,0 | 3 | 3,0 | 3 |
| Laureles Stadium | La Floresta | 9,9 | 3 | 3,0 | 3 |
| San Javier | El Socorro | 9,9 | 3 | 3,2 | 3 |
| Castile | Castile | 9,9 | 3 | 3,4 | 3 |
| Oak wood | San Cristóbal Expansion Area | 9,9 | 3 | 3,6 | 3 |
| Castile | Weave it | 9,9 | 3 | 3,3 | 3 |
| Beautiful Villa | Los Angeles | 9,9 | 3 | 3,5 | 3 |
| Beautiful Villa | Boston | 9,9 | 3 | 3,5 | 3 |



| | | | | | |
|--------------------|---------------------|-----|---|-----|---|
| Oak wood | Saint Benedict | 9,9 | 3 | 3,3 | 3 |
| Laureles Stadium | New Florida | 9,9 | 3 | 3,0 | 3 |
| Popular | Granizal | 9,9 | 3 | 3,2 | 3 |
| Santa Cruz | San Isidro | 9,9 | 3 | 3,2 | 3 |
| La Candelaria | Barrio Colombia | 9,8 | 3 | 3,4 | 3 |
| Popular | Saint Paul | 9,8 | 3 | 3,1 | 3 |
| Santa Cruz | The Border | 9,8 | 3 | 3,4 | 3 |
| The America | San Javier No.1 | 9,8 | 3 | 3,3 | 3 |
| Popular | Berlin | 9,8 | 3 | 3,2 | 3 |
| Twelfth of October | Progress No.2 | 9,8 | 3 | 3,5 | 3 |
| Buenos Aires | Gerona | 9,8 | 3 | 3,4 | 3 |
| Castile | B. Cerro El Volador | 9,8 | 3 | 3,5 | 3 |
| Aranjuez | Caribbean | 9,7 | 3 | 3,5 | 3 |
| Laureles Stadium | Calasanz | 9,7 | 3 | 2,9 | 2 |
| Manrique | Manrique Oriental | 9,7 | 3 | 3,1 | 3 |
| Popular | Carpinelo | 9,7 | 3 | 3,5 | 3 |
| The Village | The Village | 9,7 | 3 | 2,6 | 2 |
| Castile | Pedregal | 9,7 | 3 | 3,2 | 3 |
| La Candelaria | New Street | 9,6 | 3 | 3,2 | 3 |
| Santa Cruz | Palermo | 9,6 | 3 | 3,5 | 3 |
| San Javier | Antonio Nariño | 9,6 | 3 | 3,0 | 3 |
| Buenos Aires | The Miraculous | 9,6 | 3 | 3,4 | 3 |
| Manrique | The Raizal | 9,6 | 3 | 3,2 | 3 |
| San Javier | Eduardo Santos | 9,6 | 3 | 3,4 | 3 |
| Laureles Stadium | The Acacias | 9,6 | 3 | 3,1 | 3 |
| Popular | France | 9,6 | 3 | 3,1 | 3 |
| Manrique | The Cross | 9,6 | 3 | 3,4 | 3 |
| Oak wood | Villa Flora | 9,6 | 3 | 3,1 | 3 |
| Popular | Villa del Socorro | 9,5 | 3 | 3,1 | 3 |
| Laureles Stadium | Miravalle | 9,5 | 3 | 3,1 | 3 |
| Manrique | Versailles No.1 | 9,5 | 3 | 3,1 | 3 |



| | | | | | |
|------------------|------------------------------|-----|---|-----|---|
| Popular | Andalusia | 9,5 | 3 | 3,2 | 3 |
| Laureles Stadium | Ferrini | 9,5 | 3 | 3,0 | 3 |
| Castile | Francisco Antonio Zea | 9,5 | 3 | 3,0 | 3 |
| Manrique | Meadow | 9,5 | 3 | 3,1 | 3 |
| Santa Cruz | Paul VI | 9,5 | 3 | 3,1 | 3 |
| Oak wood | Fourth Brigade | 9,5 | 3 | 2,9 | 2 |
| The America | Twenty of July | 9,5 | 3 | 3,1 | 3 |
| Beautiful Villa | Villa Lilliam | 9,5 | 3 | 3,8 | 3 |
| Popular | The Advanced | 9,5 | 3 | 3,4 | 3 |
| Castile | Lopez de Mesa | 9,5 | 3 | 3,2 | 3 |
| Manrique | Versailles No.2 | 9,5 | 3 | 3,4 | 3 |
| Laureles Stadium | The Pines | 9,4 | 3 | 2,7 | 2 |
| Manrique | The piñuela | 9,4 | 3 | 3,0 | 3 |
| Beautiful Villa | San Antonio | 9,4 | 3 | 3,9 | 3 |
| Laureles Stadium | San Joaquin | 9,4 | 3 | 3,0 | 3 |
| Popular | Santo Domingo Savio No.2 | 9,4 | 3 | 3,7 | 3 |
| Castile | Córdoba | 9,4 | 3 | 3,0 | 3 |
| Beautiful Villa | The Pinal | 9,4 | 3 | 3,4 | 3 |
| La Candelaria | Villa Station | 9,4 | 3 | 3,6 | 3 |
| Popular | Moscow No.2 | 9,4 | 3 | 2,8 | 2 |
| Oak wood | New Villa of La Iguaná | 9,4 | 3 | 3,7 | 3 |
| Popular | Villa Guadalupe | 9,4 | 3 | 2,9 | 2 |
| Aranjuez | St. Vincent de Paul Hospital | 9,4 | 3 | 3,0 | 3 |
| Buenos Aires | Miraflores | 9,4 | 3 | 3,2 | 3 |
| Manrique | Valdés Field No.1 | 9,3 | 3 | 2,9 | 2 |
| Castile | Boyacá | 9,3 | 3 | 3,1 | 3 |
| Manrique | Orient | 9,3 | 3 | 3,3 | 3 |
| The America | Santa Monica | 9,3 | 3 | 2,8 | 2 |
| Aranjuez | Aranjuez | 9,3 | 3 | 2,9 | 2 |
| Manrique | Saint Agnes | 9,3 | 3 | 3,0 | 3 |
| The Village | Guayabal | 9,3 | 3 | 3,3 | 3 |



| | | | | | |
|--------------------|-------------------------|-----|---|-----|---|
| Beautiful Villa | Freedom | 9,2 | 3 | 3,4 | 3 |
| The Village | Love Field | 9,2 | 3 | 3,2 | 3 |
| La Candelaria | Heart of Jesus | 9,2 | 3 | 3,1 | 3 |
| Popular | Maria Cano-Carambolas | 9,2 | 3 | 3,3 | 3 |
| Oak wood | Olaya Herrera | 9,2 | 3 | 3,3 | 3 |
| Bethlehem | The Alps | 9,2 | 3 | 3,2 | 3 |
| San Javier | El Salado | 9,2 | 3 | 3,1 | 3 |
| Aranjuez | The Chagualo | 9,2 | 3 | 3,3 | 3 |
| Castile | Santander | 9,2 | 3 | 3,1 | 3 |
| Manrique | The Farms | 9,2 | 3 | 3,0 | 3 |
| Manrique | The Pomar | 9,2 | 3 | 2,9 | 2 |
| Bethlehem | Saint Bernard | 9,2 | 3 | 3,2 | 3 |
| La Candelaria | Orange grove | 9,2 | 3 | 3,1 | 3 |
| Laureles Stadium | The Velodrome | 9,2 | 3 | 2,7 | 2 |
| Oak wood | Palisade | 9,1 | 3 | 2,8 | 2 |
| Oak wood | The Colors | 9,1 | 3 | 2,8 | 2 |
| Twelfth of October | Twelfth of October No.1 | 9,1 | 3 | 3,2 | 3 |
| Oak wood | Saint Margaret | 9,1 | 3 | 2,9 | 2 |
| Manrique | San Jose La Cima No.2 | 9,1 | 3 | 3,2 | 3 |
| The America | The Alcazars | 9,1 | 3 | 2,7 | 2 |
| San Javier | Metropolitan | 9,1 | 3 | 2,7 | 2 |
| The America | Calasanz Upper Part | 9,1 | 3 | 2,7 | 2 |
| Popular | La Salle | 9,1 | 3 | 2,8 | 2 |
| Oak wood | Oak wood | 9,1 | 3 | 3,0 | 3 |
| Laureles Stadium | Bolivarian | 9,0 | 3 | 2,7 | 2 |
| La Candelaria | Perpetual Help | 9,0 | 3 | 3,1 | 3 |
| Santa Cruz | Belalcázar | 9,0 | 3 | 3,0 | 3 |
| Manrique | The Emeralds | 9,0 | 3 | 2,8 | 2 |
| Twelfth of October | Aures No.2 | 9,0 | 3 | 2,9 | 2 |
| Beautiful Villa | The Estancias | 9,0 | 3 | 3,5 | 3 |
| Manrique | Valdés Field No.2 | 9,0 | 3 | 2,8 | 2 |



| | | | | | |
|--------------------|---|-----|---|-----|---|
| Popular | Popular | 8,9 | 3 | 2,9 | 2 |
| Oak wood | Urban Capital Corregimiento San Cristóbal | 8,9 | 3 | 2,7 | 2 |
| Popular | The Island | 8,9 | 3 | 2,8 | 2 |
| Laureles Stadium | Stadium | 8,9 | 3 | 2,6 | 2 |
| Beautiful Villa | Villatina | 8,9 | 2 | 3,4 | 3 |
| Twelfth of October | The Triumph | 8,9 | 2 | 3,3 | 3 |
| Castile | Universal Cemetery | 8,9 | 2 | 2,7 | 2 |
| The Village | Christ the King | 8,9 | 2 | 2,8 | 2 |
| Laureles Stadium | El Nogal-Los Almendros | 8,8 | 2 | 2,9 | 2 |
| Castile | Florence | 8,8 | 2 | 2,8 | 2 |
| Oak wood | Aures No.1 | 8,8 | 2 | 2,7 | 2 |
| Bethlehem | Grenade | 8,8 | 2 | 3,1 | 3 |
| Popular | San Jose La Cima No.1 | 8,8 | 2 | 3,1 | 3 |
| Manrique | The Mansion | 8,8 | 2 | 2,8 | 2 |
| Laureles Stadium | Laurels | 8,8 | 2 | 2,6 | 2 |
| Castile | Girardot | 8,8 | 2 | 2,9 | 2 |
| The Village | Los Balsos No.2 | 8,8 | 2 | 2,2 | 2 |
| The Village | Manila | 8,7 | 2 | 2,6 | 2 |
| Beautiful Villa | The Mangoes | 8,7 | 2 | 3,2 | 3 |
| Beautiful Villa | Sucre | 8,7 | 2 | 3,1 | 3 |
| Laureles Stadium | Fourth Brigade Battalion | 8,7 | 2 | 2,4 | 2 |
| Oak wood | Faculty of Mines U. National | 8,7 | 2 | 2,6 | 2 |
| Beautiful Villa | LLanaditas | 8,7 | 2 | 3,4 | 3 |
| Castile | Forests of São Paulo | 8,7 | 2 | 2,6 | 2 |
| The Village | Villa Carlota | 8,7 | 2 | 2,8 | 2 |
| Bethlehem | The Hill | 8,7 | 2 | 2,7 | 2 |
| Bethlehem | Altavista | 8,6 | 2 | 3,2 | 3 |
| Bethlehem | Tenche | 8,6 | 2 | 3,5 | 3 |
| Bethlehem | The Corner | 8,6 | 2 | 3,0 | 3 |
| The America | Little nativity scene | 8,6 | 2 | 2,6 | 2 |
| Beautiful Villa | San Miguel | 8,5 | 2 | 2,9 | 2 |



| | | | | | |
|------------------|-------------------------|-----|---|-----|---|
| Bethlehem | La Palma | 8,5 | 2 | 2,8 | 2 |
| Beautiful Villa | Enciso | 8,5 | 2 | 3,0 | 3 |
| The America | Bethany | 8,5 | 2 | 2,6 | 2 |
| Beautiful Villa | Villa Turbay | 8,5 | 2 | 3,3 | 3 |
| Castile | Altamira | 8,5 | 2 | 2,5 | 2 |
| Oak wood | La Pilarica | 8,4 | 2 | 2,5 | 2 |
| Buenos Aires | El Salvador | 8,4 | 2 | 2,8 | 2 |
| The America | Saint Lucia | 8,4 | 2 | 2,4 | 2 |
| Oak wood | Cockroach | 8,4 | 2 | 2,6 | 2 |
| Oak wood | Carlos E. Restrepo | 8,4 | 2 | 2,9 | 2 |
| Bethlehem | Trinity | 8,4 | 2 | 2,8 | 2 |
| Beautiful Villa | Alejandro Echavarria | 8,4 | 2 | 3,1 | 3 |
| Oak wood | Pajarito Expansion Area | 8,3 | 2 | 2,5 | 2 |
| The Village | Alexandria | 8,3 | 2 | 2,2 | 2 |
| Oak wood | Nameless | 8,3 | 2 | 2,7 | 2 |
| Oak wood | San Germán | 8,3 | 2 | 2,9 | 2 |
| The America | Santa Rosa de Lima | 8,3 | 2 | 2,6 | 2 |
| Laureles Stadium | Fatima | 8,3 | 2 | 2,4 | 2 |
| Popular | Moscow No.1 | 8,2 | 2 | 2,5 | 2 |
| Laureles Stadium | St. Therese | 8,2 | 2 | 2,4 | 2 |
| Laureles Stadium | The Mercedes | 8,2 | 2 | 2,6 | 2 |
| Beautiful Villa | The Sierra | 8,2 | 2 | 3,1 | 3 |
| Castile | Fair Square | 8,2 | 2 | 2,9 | 2 |
| Buenos Aires | Las Palmas | 8,2 | 2 | 2,7 | 2 |
| Oak wood | Birdie | 8,2 | 2 | 2,4 | 2 |
| Bethlehem | The Violets | 8,2 | 2 | 2,7 | 2 |
| San Javier | The Heart | 8,2 | 2 | 2,3 | 2 |
| The Village | Nice Patio | 8,2 | 2 | 2,2 | 2 |
| La Candelaria | South american | 8,2 | 2 | 2,2 | 2 |
| Buenos Aires | Loreto | 8,1 | 2 | 2,6 | 2 |
| The Village | Astorga | 8,1 | 2 | 2,4 | 2 |



| | | | | | |
|------------------|--|-----|---|-----|---|
| Laureles Stadium | New Villa del Aburrá | 8,1 | 2 | 2,6 | 2 |
| Aranjuez | Transport Terminal | 8,1 | 2 | 2,4 | 2 |
| Castile | Las Brisas | 8,1 | 2 | 2,5 | 2 |
| Bethlehem | The Beaches | 8,1 | 2 | 2,6 | 2 |
| Oak wood | Faculty of Mines | 8,1 | 2 | 2,3 | 2 |
| Beautiful Villa | Beautiful Villa | 8,1 | 2 | 2,6 | 2 |
| Oak wood | Faculty of Veterinary Medicine and Zootechnics U.de.A. | 8,1 | 2 | 2,5 | 2 |
| The Village | La Florida | 8,1 | 2 | 2,0 | 2 |
| Beautiful Villa | John Paul II | 8,1 | 2 | 3,1 | 3 |
| Beautiful Villa | Neighborhoods of Jesus | 8,0 | 2 | 2,9 | 2 |
| Buenos Aires | Asomadera No.1 | 8,0 | 2 | 2,3 | 2 |
| La Candelaria | Santa Fe | 8,0 | 2 | 2,6 | 2 |
| Buenos Aires | Castropol | 7,9 | 2 | 2,1 | 2 |
| La Candelaria | The Conquerors | 7,9 | 2 | 2,3 | 2 |
| The Village | La Aguacatala | 7,8 | 2 | 2,1 | 2 |
| Aranjuez | Oil pipeline | 7,8 | 2 | 2,3 | 2 |
| Buenos Aires | Los Cerros El Vergel | 7,8 | 2 | 2,6 | 2 |
| The America | Campo Alegre | 7,7 | 2 | 2,2 | 2 |
| Buenos Aires | Eight of March | 7,7 | 2 | 2,9 | 2 |
| Laureles Stadium | The Castellana | 7,7 | 2 | 2,3 | 2 |
| Laureles Stadium | Rosales | 7,7 | 2 | 2,4 | 2 |
| The Village | Lalinde | 7,7 | 2 | 1,9 | 1 |
| Bethlehem | The Glory | 7,7 | 2 | 2,5 | 2 |
| Santa Cruz | Tuscany | 7,6 | 2 | 2,4 | 2 |
| Bethlehem | Altavista Expansion Area | 7,6 | 2 | 2,9 | 2 |
| Oak wood | Monteclaro | 7,6 | 2 | 2,1 | 2 |
| Laureles Stadium | U.D. Athanasius Girardot | 7,6 | 2 | 2,0 | 2 |
| Buenos Aires | Asomadera No.2 | 7,5 | 2 | 2,2 | 2 |
| The Village | Santa Maria de Los Angeles | 7,5 | 2 | 2,4 | 2 |
| Buenos Aires | Las Lomas No.1 | 7,5 | 2 | 1,8 | 1 |
| Santa Cruz | Tercentenary | 7,4 | 2 | 2,4 | 2 |



| | | | | | |
|------------------------------------|-------------------------------------|-----|---|-----|---|
| Santa Cruz | Hector Abad Gomez | 7,4 | 2 | 2,1 | 2 |
| Bethlehem | Belén Rincón Expansion Area | 7,3 | 2 | 2,4 | 2 |
| Santa Cruz | Playón de Los Comuneros | 7,3 | 2 | 2,5 | 2 |
| The Village | The Castle | 7,3 | 2 | 1,8 | 1 |
| Buenos Aires | San Diego | 7,3 | 2 | 2,1 | 2 |
| Bethlehem | The Loma de Los Bernal | 7,3 | 2 | 2,2 | 2 |
| Oak wood | La Loma | 7,2 | 2 | 1,9 | 2 |
| La Candelaria | Administrative Centre | 7,2 | 2 | 1,8 | 1 |
| Twelfth of October | Nameless | 7,2 | 2 | 2,0 | 2 |
| Corr. of San Cristóbal | The LLano | 7,2 | 2 | 1,7 | 1 |
| Twelfth of October | The Picacho | 7,1 | 2 | 1,8 | 1 |
| Aranjuez | University of Antioquia | 7,1 | 2 | 1,9 | 1 |
| Bethlehem | La Mota | 7,0 | 2 | 2,2 | 2 |
| Corr. of San Antonio de Prado | San Antonio de Prado | 7,0 | 2 | 2,2 | 2 |
| Buenos Aires | Bomboná No.2 | 6,9 | 2 | 2,1 | 2 |
| The Village | The Orange Trees | 6,9 | 2 | 1,5 | 1 |
| Corr. of San Antonio de Prado | San Antonio de Prado Expansion Area | 6,9 | 2 | 2,2 | 2 |
| Manrique | Girardot Battalion | 6,9 | 2 | 1,8 | 1 |
| The Village | The Treasury | 6,8 | 2 | 1,5 | 1 |
| Laureles Stadium | U.P.B | 6,8 | 2 | 1,9 | 1 |
| Corr. of San Cristóbal | Crossings | 6,7 | 1 | 1,5 | 1 |
| Buenos Aires | Catalonia | 6,7 | 1 | 1,9 | 1 |
| Aranjuez | National University | 6,7 | 1 | 1,8 | 1 |
| Corr. of San Cristóbal | Pedregal Alto | 6,7 | 1 | 1,5 | 1 |
| Bethlehem | Diego Echavarria | 6,7 | 1 | 1,9 | 1 |
| The Village | Los Balsos No.1 | 6,7 | 1 | 1,4 | 1 |
| Bethlehem | El Noral Expansion Area | 6,6 | 1 | 2,3 | 2 |
| Corr. of San Cristóbal | The Illusion | 6,6 | 1 | 1,5 | 1 |
| Corr. of San Sebastián de Palmitas | The Uvito | 6,6 | 1 | 1,5 | 1 |



| | | | | | |
|------------------------------------|--------------------------|-----|---|-----|---|
| The Village | Diamond No.2 | 6,5 | 1 | 1,7 | 1 |
| Buenos Aires | Las Lomas No.2 | 6,5 | 1 | 1,3 | 1 |
| Corr. of San Cristóbal | The Beaches | 6,5 | 1 | 1,4 | 1 |
| Corr. of San Sebastián de Palmitas | The Blade | 6,5 | 1 | 1,4 | 1 |
| Aranjuez | North Park | 6,5 | 1 | 2,0 | 2 |
| Beautiful Villa | The Hillside | 6,5 | 1 | 1,9 | 1 |
| Bethlehem | La Hondonada | 6,4 | 1 | 2,0 | 2 |
| Buenos Aires | Altos del Poblado | 6,4 | 1 | 1,4 | 1 |
| Bethlehem | John Paul II Park | 6,4 | 1 | 1,8 | 1 |
| Corr. of San Cristóbal | Yolombo | 6,3 | 1 | 1,4 | 1 |
| La Candelaria | The Alpujarra | 6,3 | 1 | 1,6 | 1 |
| Corr. of San Cristóbal | Carmel | 6,3 | 1 | 1,4 | 1 |
| Buenos Aires | Asomadera No.3 | 6,1 | 1 | 1,3 | 1 |
| Corr. of San Sebastián de Palmitas | Anchovy | 6,1 | 1 | 1,2 | 1 |
| Aranjuez | Botanical garden | 6,1 | 1 | 1,7 | 1 |
| Corr. of San Cristóbal | San Jose de La Montaña | 6,0 | 1 | 1,2 | 1 |
| Bethlehem | The Rodeo | 6,0 | 1 | 1,5 | 1 |
| Laureles Stadium | El Morro Heart | 5,8 | 1 | 1,1 | 1 |
| Castile | Cerro El Volador Ecopark | 5,8 | 1 | 1,7 | 1 |
| Corr. of San Sebastián de Palmitas | Orange grove | 5,7 | 1 | 1,0 | 1 |
| Beautiful Villa | Las Palmas | 5,6 | 1 | 1,1 | 1 |
| The Village | Saint Luke | 5,5 | 1 | 1,2 | 1 |
| Corr. of San Sebastián de Palmitas | The Courtyard | 5,5 | 1 | 1,0 | 1 |
| Corr. of Santa Elena | The Plan | 5,5 | 1 | 1,2 | 1 |
| Bethlehem | San Jose del Manzanillo | 5,5 | 1 | 1,4 | 1 |
| Corr. of San Sebastián de Palmitas | The Village | 5,5 | 1 | 1,2 | 1 |
| Bethlehem | Altavista Sectro Central | 5,5 | 1 | 1,4 | 1 |
| Corr. of Altavista | El Salado | 5,4 | 1 | 1,2 | 1 |



| | | | | | |
|------------------------------------|----------------------------|-----|---|-----|---|
| Corr. of San Antonio de Prado | Montanita | 5,3 | 1 | 1,2 | 1 |
| Bethlehem | Saint Paul | 5,3 | 1 | 1,2 | 1 |
| Corr. of San Sebastián de Palmitas | The Frisola | 5,2 | 1 | 1,1 | 1 |
| Corr. of San Cristóbal | La Palma | 5,1 | 1 | 0,8 | 1 |
| Corr. of Altavista | The Green | 5,0 | 1 | 1,1 | 1 |
| Corr. of San Antonio de Prado | San Jose | 5,0 | 1 | 1,2 | 1 |
| Bethlehem | Hope | 5,0 | 1 | 1,1 | 1 |
| Beautiful Villa | Crescent | 4,8 | 1 | 1,0 | 1 |
| Corr. of San Sebastián de Palmitas | The Dirty | 4,8 | 1 | 1,0 | 1 |
| Corr. of San Antonio de Prado | Potrero | 4,8 | 1 | 1,0 | 1 |
| Popular | Piedras Blancas - Matasano | 4,7 | 1 | 0,9 | 1 |
| Corr. of San Sebastián de Palmitas | Guayabal Volcano | 4,6 | 1 | 0,9 | 1 |
| Corr. of San Sebastián de Palmitas | Urquita | 4,6 | 1 | 0,9 | 1 |
| Corr. of San Antonio de Prado | La Florida | 4,6 | 1 | 1,0 | 1 |
| Corr. of San Sebastián de Palmitas | Potrera Miserenga | 4,6 | 1 | 0,9 | 1 |
| Corr. of Santa Elena | Santa Elena Sector Central | 4,5 | 1 | 0,9 | 1 |
| Corr. of Altavista | Buga Patio Bonito | 4,5 | 1 | 0,9 | 1 |
| Corr. of San Sebastián de Palmitas | Switzerland | 4,4 | 1 | 0,8 | 1 |
| Corr. of Altavista | Cold Waters | 4,4 | 1 | 0,9 | 1 |
| Corr. of Santa Elena | Pleasure | 4,4 | 1 | 0,8 | 1 |
| Corr. of San Sebastián de Palmitas | The Shipyard | 4,4 | 1 | 0,8 | 1 |
| Corr. of San Sebastián de Palmitas | Yarumalito | 4,4 | 1 | 0,8 | 1 |
| Corr. of Santa Elena | Fat Stone | 4,3 | 1 | 0,8 | 1 |



| | | | | | |
|------------------------------------|-------------------------|-----|---|-----|---|
| Corr. of San Sebastián de Palmitas | Palmitas Sector Central | 4,2 | 1 | 0,7 | 1 |
| Corr. of Santa Elena | The LLano SE | 4,2 | 1 | 0,7 | 1 |
| Corr. of Santa Elena | Mallet | 4,1 | 1 | 0,7 | 1 |
| Corr. of Altavista | The Garden | 4,0 | 1 | 0,7 | 1 |
| Corr. of Santa Elena | White Mud | 4,0 | 1 | 0,7 | 1 |
| Corr. of Santa Elena | The Hill | 4,0 | 1 | 0,7 | 1 |

Table 6.9: Average of prom range and *subretos*

Annex 5: Analysis of benefits and scale of NBS in the GreenUP NBS Catalogue

Early actions of Medellín or Nature-Based Solutions prior to the URBAN GreenUP project and its relationship with the Manual of Public Space

| INFRASTRUCTURE | NBS CATEGORY | NBS | NBS SOURCE |
|----------------|-----------------------|---|------------------------------------|
| Blue | Flood actions | Urban forest catchment areas | URBAN GreenUP |
| Blue | Flood actions | Flood park | URBAN GreenUP |
| Blue | Flood actions | Preventing flooding from hard drains - Dig up waterways | URBAN GreenUP |
| Blue | Flood actions | Renaturalization of channels | URBAN GreenUP |
| Blue | Flood actions | Collective orchards | Early Actions of Medellín |
| Grey | Urban agriculture | Urban composting | URBAN GreenUP |
| Grey | Urban agriculture | Small-scale urban livestock | URBAN GreenUP |
| Grey | Urban agriculture | Urban gardens | URBAN GreenUP |
| Grey | Urban agriculture | Climate-smart greenhouses | URBAN GreenUP |
| Green | Low-impact rest areas | Green rest areas | URBAN GreenUP |
| Green | Low-impact rest areas | Pocket green parks | Early Actions of Medellín |
| Green | Low-impact rest areas | Low-impact green parks in creek retreats | Early Actions of Medellín |
| Green | Low-impact rest areas | Resting antegardens | Early Actions of Medellín |
| Blue | Sustainable drains | Grass and water retention swamp | URBAN GreenUP |
| Blue | Sustainable drains | Rain gardens | URBAN GreenUP |
| Blue | Sustainable drains | Sustainable drainage systems | URBAN GreenUP |
| Blue | Sustainable drains | Drainage in Escalanados Gardens | Early Actions of Medellín |
| Blue | Sustainable drains | Surface drainage | Manual of Public Space of Medellín |
| Blue | Sustainable drains | Channels to channel runoff water | Manual of Public Space of Medellín |
| Blue | Sustainable drains | Coronation trenches | Manual of Public Space of Medellín |
| Blue | Sustainable drains | Coronation dams | Manual of Public Space of Medellín |
| Blue | Sustainable drains | French drains | Manual of Public Space of Medellín |



| INFRASTRUCTURE | NBS CATEGORY | NBS | NBS SOURCE |
|----------------|----------------------------------|--|------------------------------------|
| Blue | Sustainable drains | Canals | Manual of Public Space of Medellín |
| Blue | Sustainable drains | Revegetation | Manual of Public Space of Medellín |
| Grey | Contaminant filter | Green filter area (air) | URBAN GreenUP |
| Grey | Contaminant filter | Urban garden biofilter | URBAN GreenUP |
| Green | Horizontal green infrastructures | Roofs with green covers | URBAN GreenUP |
| Green | Horizontal green infrastructures | Green roofs | URBAN GreenUP |
| Green | Horizontal green infrastructures | Green shading structures | URBAN GreenUP |
| Green | Horizontal green infrastructures | Constructed wetlands electricity generators | URBAN GreenUP |
| Green | Horizontal green infrastructures | Floating gardens | URBAN GreenUP |
| Green | Vertical green infrastructures | Green barriers to mitigate noise | URBAN GreenUP |
| Green | Vertical green infrastructures | Green fences | URBAN GreenUP |
| Green | Vertical green infrastructures | Green facades | URBAN GreenUP |
| Green | Vertical green infrastructures | Green facades with vine plants | URBAN GreenUP |
| Green | Vertical green infrastructures | Hydroponic green facades | URBAN GreenUP |
| Green | Vertical green infrastructures | Portable vertical garden | URBAN GreenUP |
| Green | Vertical green infrastructures | Stepped gardens | Early Actions of Medellín |
| Green | Vertical green infrastructures | Green walls in building cylinder heads | Early Actions of Medellín |
| Green | Vertical green infrastructures | Green walls with independent structures | Early Actions of Medellín |
| Green | Vertical green infrastructures | Green poles | Early Actions of Medellín |
| Green | Vertical green infrastructures | Green walls vehicular bridges | Early Actions of Medellín |
| Green | Vertical green infrastructures | Green walls mass transit system structures | Early Actions of Medellín |
| Green | Vertical green infrastructures | Gabion walls | Manual of Public Space of Medellín |
| Green | Vertical green infrastructures | stone accommodated | Manual of Public Space of Medellín |
| Green | Vertical green infrastructures | Retention screens (armed ground) | Manual of Public Space of Medellín |
| Green | Vertical green infrastructures | Anchored meshes | Manual of Public Space of Medellín |
| Green | Vertical green infrastructures | Enrocados | Manual of Public Space of Medellín |
| Green | Vertical green infrastructures | Walls on reinforced soil or reinforced earth | Manual of Public Space of Medellín |



| INFRASTRUCTURE | NBS CATEGORY | NBS | NBS SOURCE |
|----------------|--|---|------------------------------------|
| Green | Vertical green infrastructures | Wood trinchos | Manual of Public Space of Medellín |
| Green | Vertical green infrastructures | Living barriers | Manual of Public Space of Medellín |
| Green | Vertical green infrastructures | Fique packaging mattresses | Manual of Public Space of Medellín |
| Green | Vertical green infrastructures | Protection with biosolids | Manual of Public Space of Medellín |
| Green | Vertical green infrastructures | Fertile celobiose paste | Manual of Public Space of Medellín |
| Grey | Tree Interventions | Urban trees | URBAN GreenUP |
| Grey | Tree Interventions | Wooded areas on the urban perimeter | URBAN GreenUP |
| Grey | Tree Interventions | Trees for temperature reduction | URBAN GreenUP |
| Grey | Tree Interventions | Planting and renovation of urban trees | URBAN GreenUP |
| Grey | Tree Interventions | Trees in parking lots | URBAN GreenUP |
| Grey | Tree Interventions | Reforestation | Manual of Public Space of Medellín |
| Grey | Tree Interventions | Natural regeneration | Manual of Public Space of Medellín |
| Green | Green pavements | Cold pavement | URBAN GreenUP |
| Green | Green pavements | Green cycle-pedestrian pavements | URBAN GreenUP |
| Green | Green pavements | Permeable pavements | URBAN GreenUP |
| Green | Green pavements | Green pavements and parking lots | URBAN GreenUP |
| Green | Green pavements | Green cycle-pedestrian routes | URBAN GreenUP |
| Green | Green pavements | Permeable pavements | Early Actions of Medellín |
| Green | Green pavements | Elevated floor level circulations | Early Actions of Medellín |
| Green | Green pavements | Empradizados (engramado) | Manual of Public Space of Medellín |
| Green | Green pavements | Matted | Manual of Public Space of Medellín |
| Grey | Surfaces with attractor species of Pollinators | Berms and spaces for nearby pollinators | URBAN GreenUP |
| Grey | Surfaces with attractor species of Pollinators | Compact pollinator modules | URBAN GreenUP |
| Grey | Surfaces with attractor species of Pollinators | Natural pollinator modules | URBAN GreenUP |



| INFRASTRUCTURE | NBS CATEGORY | NBS | NBS SOURCE |
|----------------|--|--|---------------------------|
| Grey | Surfaces with attractor species of Pollinators | Walls for pollinators | URBAN GreenUP |
| Grey | Surfaces with attractor species of Pollinators | Green roof for pollinators | URBAN GreenUP |
| Grey | Surfaces with attractor species of Pollinators | Open butterfly garden | Early Actions of Medellín |
| Grey | Surfaces with attractor species of Pollinators | Staggered pollinators | Early Actions of Medellín |
| Grey | Smart floors | Improving soil management and nutrient release | URBAN GreenUP |
| Grey | Smart floors | Production of smart soils in the urban agricultural area | URBAN GreenUP |
| Blue | Water treatment | Green filter area (water) | URBAN GreenUP |
| Blue | Water treatment | Natural wastewater treatment | URBAN GreenUP |

Table 6.10: Early actions or NBS prior to the URBAN GreenUP project

6.5.1 Potential NBS application scales

| Type of Infrastructure (UGU) | NBS CATEGORY | Total in Micro Scale | Total in Meso Scale | Total in Macro Scale |
|------------------------------|--|----------------------|---------------------|----------------------|
| Blue | Flood actions | 3 | 2 | 2 |
| Grey | Urban agriculture | 3 | 2 | 1 |
| Green | Rest areas | 5 | 3 | 0 |
| Blue | Sustainable drains | 7 | 11 | 6 |
| Grey | Contaminant filter | 2 | 0 | 0 |
| Green | Horizontal green infrastructures | 5 | 3 | 1 |
| Green | Vertical green infrastructures | 23 | 2 | 0 |
| Grey | Tree Interventions | 3 | 6 | 5 |
| Green | Green pavements | 9 | 9 | 0 |
| Grey | Smart floors | 2 | 0 | 0 |
| Grey | Surfaces with attractor species of Pollinators | 7 | 0 | 0 |
| Blue | Water treatment | 2 | 1 | 1 |
| | Overall total | 71 | 39 | 16 |

Table 6.11: Potential scales for NBS application



6.5.2 Potential Contributions of NBS to Ecosystem Services and Territorial Supply

| bRetos | Category NBS | Application Scales | | | ECOSYSTEM SERVICES | | | | | | | | | | | Main (3) | Intermediate (2) | Tertiary (1) |
|-----------------|---|--------------------------------|---------------------------------------|--------------|---|--------------------------------|---|--|--|---|----------------------------|-------------------|------|---|--------------------------------------|---|--|--|
| | | Ma | Me | My | REGULATION AND SUPPORT | | | | | | PROVISION | | | CULTURAL | | | | |
| | | Macro (Municipality/Cuenca) | Meso (Barrio/Comuna/Corregimiento) | Micro (Site) | Moderation of extreme events (by mass movements, torrential avenues). | Erosion prevention and control | Transport and dilution of liquid contaminants | Capture of particulate matter from the air | Microclimatic regulation (heat island reduction, noise mitigation, carbon storage) | Habitat conservation for biological diversity (biological control, pollination, habitat provision, refuge and breeding) | Water (Water availability) | Food and medicine | Wood | Non-timber ornamental and forest products | Scenic and sensory value or interest | Religious/spiritual/cultural/historical value or interest | Recreational and tourist value or interest | Cognitive value or interest (art, education and science) |
| 1.1. Adaptation | Surfaces with attractor species of Pollinators (Pollinator) | 0 | 0 | MY | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 3 | 0 | 0 | 1 | 0 | 0 | 2 |
| 1.1. Adaptation | Vertical green infrastructures (Vertical GI) | 0 | ME | MY | 0 | 0 | 0 | 3 | 3 | 1 | 0 | 0 | 0 | 3 | 3 | 1 | 0 | 3 |
| 1.1. Adaptation | Arboreal Interventions | MA | ME | MY | 3 | 3 | 0 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| 1.1. Adaptation | Green pavements | 0 | ME | MY | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 1 | 3 |
| 1.1. Adaptation | Flood actions | MA | ME | MY | 3 | 3 | 3 | 0 | 1 | 1 | 3 | 0 | 0 | 0 | 3 | 1 | 2 | 3 |
| 1.1. Adaptation | Sustainable drains (SUDs) | MA | ME | MY | 3 | 2 | 3 | 0 | 1 | 0 | 3 | 0 | 0 | 0 | 3 | 1 | 3 | 3 |
| 1.1. Adaptation | Resting areas | 0 | ME | MY | 0 | 0 | 0 | 0 | 2 | 1 | 0 | 1 | 1 | 2 | 3 | 3 | 3 | 3 |
| 1.1. Adaptation | Smart soils | 0 | 0 | MY | 1 | 1 | 0 | 0 | 0 | 2 | 0 | 3 | 3 | 3 | 0 | 1 | 0 | 3 |
| 1.1. Adaptation | Pollutants filter | 0 | 0 | MY | 0 | 0 | 3 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| 1.1. Adaptation | Horizontal green infrastructures (Horizontal GI) | MA | ME | MY | 0 | 0 | 0 | 3 | 3 | 3 | 0 | 3 | 0 | 3 | 3 | 1 | 2 | 3 |
| 1.1. Adaptation | Urban farming | MA | ME | MY | 2 | 2 | 0 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| 1.1. Adaptation | Water treatment | MA | 0 | MY | 0 | 0 | 3 | 0 | 0 | 1 | 3 | 0 | 0 | 0 | 1 | 0 | 2 | 3 |
| 1.2. Mitigation | Panels with attractor species of Pollinators (Pollinator) | 0 | 0 | MY | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 3 | 0 | 0 | 1 | 0 | 0 | 2 |



| bRetos | Category NBS | Application Scales | | | ECOSYSTEM SERVICES | | | | | | | | | | | | Main (3) | Intermediate (2) | Tertiary (1) |
|---|--|--------------------|----|----|---|---|---|---|---|---|-----------|---|---|---|----------|---|----------|------------------|--------------|
| | | | | | REGULATION AND SUPPORT | | | | | | PROVISION | | | | CULTURAL | | | | |
| | | Ma | Me | My | (by mas s pre ven tion tion of regu late mat red ucti logi cal con | (Wa ter ava ilabi lity and me Wo od am ent al sen sor y | cul tural /his tori cal and touri st valu rest (art , edu | | | | | | | | | | | | |
| 1.2. Mitigation | Vertical green infrastructures (Vertical GI) | 0 | ME | MY | 0 | 0 | 0 | 3 | 3 | 1 | 0 | 0 | 0 | 3 | 3 | 1 | 0 | 3 | |
| 1.2. Mitigation | Arboreal Interventions | MA | ME | MY | 3 | 3 | 0 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | |
| 1.2. Mitigation | Green pavements | 0 | ME | MY | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 1 | 3 | |
| 1.2. Mitigation | Flood actions | MA | ME | MY | 3 | 3 | 3 | 0 | 1 | 1 | 3 | 0 | 0 | 0 | 3 | 1 | 2 | 3 | |
| 1.2. Mitigation | Sustainable drains (SUDs) | MA | ME | MY | 3 | 2 | 3 | 0 | 1 | 0 | 3 | 0 | 0 | 0 | 3 | 1 | 3 | 3 | |
| 1.2. Mitigation | Resting areas | 0 | ME | MY | 0 | 0 | 0 | 0 | 2 | 1 | 0 | 1 | 1 | 2 | 3 | 3 | 3 | 3 | |
| 1.2. Mitigation | Smart soils | 0 | 0 | MY | 1 | 1 | 0 | 0 | 0 | 2 | 0 | 3 | 3 | 3 | 0 | 1 | 0 | 3 | |
| 1.2. Mitigation | Pollutants filter | 0 | 0 | MY | 0 | 0 | 3 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | |
| 1.2. Mitigation | Horizontal green infrastructures (Horizontal GI) | MA | ME | MY | 0 | 0 | 0 | 3 | 3 | 3 | 0 | 3 | 0 | 3 | 3 | 1 | 2 | 3 | |
| 1.2. Mitigation | Urban farming | MA | ME | MY | 2 | 2 | 0 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | |
| 1.2. Mitigation | Water treatment | MA | 0 | MY | 0 | 0 | 3 | 0 | 0 | 1 | 3 | 0 | 0 | 0 | 1 | 0 | 2 | 3 | |
| 2.1. Water quality | Sustainable drains (SUDs) | MA | ME | MY | 3 | 2 | 3 | 0 | 1 | 0 | 3 | 0 | 0 | 0 | 3 | 1 | 3 | 3 | |
| 2.1. Water quality | Pollutants filter | 0 | 0 | MY | 0 | 0 | 3 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | |
| 2.1. Water quality | Water treatment | MA | 0 | MY | 0 | 0 | 3 | 0 | 0 | 1 | 3 | 0 | 0 | 0 | 1 | 0 | 2 | 3 | |
| 2.2. Water reuse (check if that name is the best) | Flood actions | MA | ME | MY | 3 | 3 | 3 | 0 | 1 | 1 | 3 | 0 | 0 | 0 | 3 | 1 | 2 | 3 | |
| 2.2. Water reuse (check if that name is the best) | Sustainable drains (SUDs) | MA | ME | MY | 3 | 2 | 3 | 0 | 1 | 0 | 3 | 0 | 0 | 0 | 3 | 1 | 3 | 3 | |
| 2.3. Water scarcity | Arboreal Interventions | MA | ME | MY | 3 | 3 | 0 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | |
| 2.3. Water scarcity | Flood actions | MA | ME | MY | 3 | 3 | 3 | 0 | 1 | 1 | 3 | 0 | 0 | 0 | 3 | 1 | 2 | 3 | |



| bRetos | Category NBS | Application Scales | | | ECOSYSTEM SERVICES | | | | | | | | | | | | | | | Main (3) | Intermediate (2) | Tertiary (1) |
|------------------------------|---|--------------------|----|----|------------------------|------------|---------|----|----|----|----|-----------|----|----|----|----|----------|----|----|----------|------------------|--------------|
| | | | | | REGULATION AND SUPPORT | | | | | | | PROVISION | | | | | CULTURAL | | | | | |
| | | | | | Mass | Prevention | tion of | of | of | of | of | of | of | of | of | of | of | of | of | of | of | of |
| 2.3. Water scarcity | Sustainable drains (SUDs) | MA | ME | MY | 3 | 2 | 3 | 0 | 1 | 0 | 3 | 0 | 0 | 0 | 3 | 1 | 3 | 3 | | | | |
| 2.4. Floods | Arboreal Interventions | MA | ME | MY | 3 | 3 | 0 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | | | | |
| 2.4. Floods | Green pavements | 0 | ME | MY | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 1 | 3 | | | | |
| 2.4. Floods | Flood actions | MA | ME | MY | 3 | 3 | 3 | 0 | 1 | 1 | 3 | 0 | 0 | 0 | 3 | 1 | 2 | 3 | | | | |
| 2.4. Floods | Sustainable drains (SUDs) | MA | ME | MY | 3 | 2 | 3 | 0 | 1 | 0 | 3 | 0 | 0 | 0 | 3 | 1 | 3 | 3 | | | | |
| 2.4. Floods | Horizontal green infrastructures (Horizontal GI) | MA | ME | MY | 0 | 0 | 0 | 3 | 3 | 3 | 0 | 3 | 0 | 3 | 3 | 1 | 2 | 3 | | | | |
| 3.1. Ecological Connectivity | Vertical green infrastructures (Vertical GI) | 0 | ME | MY | 0 | 0 | 0 | 3 | 3 | 1 | 0 | 0 | 0 | 3 | 3 | 1 | 0 | 3 | | | | |
| 3.1. Ecological Connectivity | Arboreal Interventions | MA | ME | MY | 3 | 3 | 0 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | | | | |
| 3.1. Ecological Connectivity | Sustainable drains (SUDs) | MA | ME | MY | 3 | 2 | 3 | 0 | 1 | 0 | 3 | 0 | 0 | 0 | 3 | 1 | 3 | 3 | | | | |
| 3.1. Ecological Connectivity | Resting areas | 0 | ME | MY | 0 | 0 | 0 | 0 | 2 | 1 | 0 | 1 | 1 | 2 | 3 | 3 | 3 | 3 | | | | |
| 3.1. Ecological Connectivity | Horizontal green infrastructures (Horizontal GI) | MA | ME | MY | 0 | 0 | 0 | 3 | 3 | 3 | 0 | 3 | 0 | 3 | 3 | 1 | 2 | 3 | | | | |
| 3.2. Ecological Diversity | Panels with attractor species of Pollinators (Pollinator) | 0 | 0 | MY | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 3 | 0 | 0 | 1 | 0 | 0 | 3 | | | | |
| 3.2. Ecological Diversity | Vertical green infrastructures (Vertical GI) | 0 | ME | MY | 0 | 0 | 0 | 3 | 3 | 1 | 0 | 0 | 0 | 3 | 3 | 1 | 0 | 3 | | | | |
| 3.2. Ecological Diversity | Arboreal Interventions | MA | ME | MY | 3 | 3 | 0 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | | | | |
| 3.2. Ecological Diversity | Flood actions | MA | ME | MY | 3 | 3 | 3 | 0 | 1 | 1 | 3 | 0 | 0 | 0 | 3 | 1 | 2 | 3 | | | | |
| 3.2. Ecological Diversity | Sustainable drains (SUDs) | MA | ME | MY | 3 | 2 | 3 | 0 | 1 | 0 | 3 | 0 | 0 | 0 | 3 | 1 | 3 | 3 | | | | |
| 3.2. Ecological Diversity | Horizontal green infrastructures (Horizontal GI) | MA | ME | MY | 0 | 0 | 0 | 3 | 3 | 3 | 0 | 3 | 0 | 3 | 3 | 1 | 2 | 3 | | | | |
| 3.2. Ecological Diversity | Urban farming | MA | ME | MY | 2 | 2 | 0 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | | | | |



| bRetos | Category NBS | Application Scales | | | ECOSYSTEM SERVICES | | | | | | | | | | | | | Main (3) | Intermediate (2) | Tertiary (1) | | | | | | | | | | | | | | | | | | | | |
|--------------------------|---|--------------------|----|----|------------------------|----|----|---------|------------|---------|-----------|-----|-----|----|----------|------|------|----------|------------------|--------------|-----|------|-----|----|----|----|----|-----|----|-----|-----|---|------|------|------|-----|----|-----|----|----|
| | | | | | REGULATION AND SUPPORT | | | | | | PROVISION | | | | CULTURAL | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | Ma | Me | My | by mass | prevention | tion of | of | ate | mat | nd | red | ucti | logi | cal | con | (Wa | ter | agai | and | me | Wo | od | am | ent | al | sen | sor | y | cult | ural | /his | ton | al | and | to | ou |
| 3.3. Ecosystem Services | Panels with attractor species of Pollinators (Pollinator) | 0 | 0 | MY | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 3 | 0 | 0 | 1 | 0 | 0 | 0 | 3 | 0 | 0 | 3 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | | | |
| 3.3. Ecosystem Services | Vertical green infrastructures (Vertical GI) | 0 | ME | MY | 0 | 0 | 0 | 3 | 3 | 1 | 0 | 0 | 0 | 3 | 3 | 1 | 0 | 0 | 3 | 0 | 0 | 3 | 0 | 0 | 3 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | | | | |
| 3.3. Ecosystem Services | Arboreal Interventions | MA | ME | MY | 3 | 3 | 0 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | | | | |
| 3.3. Ecosystem Services | Green pavements | 0 | ME | MY | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | | | |
| 3.3. Ecosystem Services | Flood actions | MA | ME | MY | 3 | 3 | 3 | 0 | 1 | 1 | 3 | 0 | 0 | 0 | 3 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | | |
| 3.3. Ecosystem Services | Sustainable drains (SUDs) | MA | ME | MY | 3 | 2 | 3 | 0 | 1 | 0 | 3 | 0 | 0 | 0 | 3 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | | |
| 3.3. Ecosystem Services | Resting areas | 0 | ME | MY | 0 | 0 | 0 | 0 | 2 | 1 | 0 | 1 | 1 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | | | | |
| 3.3. Ecosystem Services | Smart soils | 0 | 0 | MY | 1 | 1 | 0 | 0 | 0 | 2 | 0 | 3 | 3 | 3 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | | |
| 3.3. Ecosystem Services | Horizontal green infrastructures (Horizontal GI) | MA | ME | MY | 0 | 0 | 0 | 3 | 3 | 3 | 0 | 3 | 0 | 3 | 3 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | | |
| 3.3. Ecosystem Services | Urban farming | MA | ME | MY | 2 | 2 | 0 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | | | |
| 4.1. Secondary pollution | Vertical green infrastructures (Vertical GI) | 0 | ME | MY | 0 | 0 | 0 | 3 | 3 | 1 | 0 | 0 | 0 | 3 | 3 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | |
| 4.1. Secondary pollution | Arboreal Interventions | MA | ME | MY | 3 | 3 | 0 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | | | |
| 4.1. Secondary pollution | Flood actions | MA | ME | MY | 3 | 3 | 3 | 0 | 1 | 1 | 3 | 0 | 0 | 0 | 3 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| 4.1. Secondary pollution | Sustainable drains (SUDs) | MA | ME | MY | 3 | 2 | 3 | 0 | 1 | 0 | 3 | 0 | 0 | 0 | 3 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |



| bRetos | Category NBS | Application Scales | | | ECOSYSTEM SERVICES | | | | | | | | | | | | | Main (3) | Intermediate (2) | Tertiary (1) | | | | | | | | | | | | | | | | | | | | | |
|--------------------------|---|--------------------|----|----|------------------------|-------|---------|---------|------|---------|-----------|------|------|---------|----------|-----|------|----------|------------------|--------------|----|----|-----|----|-----|-----|---|------|------|------|-----|----|-----|----|----|------|------|------|-------|---|---|
| | | | | | REGULATION AND SUPPORT | | | | | | PROVISION | | | | CULTURAL | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | Ma | Me | My | by mas | s pre | vention | tion of | logu | ate mat | nd red | ucti | logi | cal con | (Wa | ter | agai | and | me | Wo | od | am | ent | al | sen | sor | y | cult | ural | /his | ton | al | and | to | ou | valu | rest | (art | , edu | | |
| 4.1. Secondary pollution | Resting areas | 0 | ME | MY | 0 | 0 | 0 | 0 | 2 | 1 | 0 | 1 | 1 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | | | |
| 4.1. Secondary pollution | Pollutants filter | 0 | 0 | MY | 0 | 0 | 3 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | | | |
| 4.1. Secondary pollution | Horizontal green infrastructures (Horizontal GI) | MA | ME | MY | 0 | 0 | 0 | 3 | 3 | 3 | 0 | 3 | 0 | 3 | 3 | 1 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | | | |
| 4.1. Secondary pollution | Urban farming | MA | ME | MY | 2 | 2 | 0 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | | |
| 4.2. Particulate matter | Vertical green infrastructures (Vertical GI) | 0 | ME | MY | 0 | 0 | 0 | 3 | 3 | 1 | 0 | 0 | 0 | 3 | 3 | 1 | 0 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | | |
| 4.2. Particulate matter | Arboreal Interventions | MA | ME | MY | 3 | 3 | 0 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | |
| 4.2. Particulate matter | Flood actions | MA | ME | MY | 3 | 3 | 3 | 0 | 1 | 1 | 3 | 0 | 0 | 0 | 3 | 1 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | |
| 4.2. Particulate matter | Sustainable drains (SUDs) | MA | ME | MY | 3 | 2 | 3 | 0 | 1 | 0 | 3 | 0 | 0 | 0 | 3 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | |
| 4.2. Particulate matter | Resting areas | 0 | ME | MY | 0 | 0 | 0 | 0 | 2 | 1 | 0 | 1 | 1 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | |
| 4.2. Particulate matter | Pollutants filter | 0 | 0 | MY | 0 | 0 | 3 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 3 | | |
| 4.2. Particulate matter | Horizontal green infrastructures (Horizontal GI) | MA | ME | MY | 0 | 0 | 0 | 3 | 3 | 3 | 0 | 3 | 0 | 3 | 3 | 1 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | |
| 4.2. Particulate matter | Urban farming | MA | ME | MY | 2 | 2 | 0 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | |
| 5.1 Urban Treatments | Panels with attractor species of Pollinators (Pollinator) | 0 | 0 | MY | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 3 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 3 | |
| 5.1 Urban Treatments | Vertical green infrastructures (Vertical GI) | 0 | ME | MY | 0 | 0 | 0 | 3 | 3 | 1 | 0 | 0 | 0 | 3 | 3 | 1 | 0 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | |
| 5.1 Urban | Arboreal Interventions | MA | ME | MY | 3 | 3 | 0 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |



| bRetos | Category NBS | Application Scales | | | ECOSYSTEM SERVICES | | | | | | | | | | | | Main (3) | Intermediate (2) | Tertiary (1) |
|--|---|--------------------|----|----|------------------------|-------------|----------------|------------------|--------------------|-------------------------|-----------------|------------|------------------|----------------------|----------------|---------------------|------------|------------------|--------------|
| | | | | | REGULATION AND SUPPORT | | | | | | PROVISION | | | | CULTURAL | | | | |
| | | Ma | Me | My | Loss prevention | Pollination | Soil formation | Water regulation | Climate regulation | Raw material production | Food production | Recreation | Waste management | Carbon sequestration | Soil fertility | Cultural/historical | Recreation | Art | Education |
| 6.1.Environmental warning environmental prevention | Flood actions | MA | ME | MY | 3 | 3 | 3 | 0 | 1 | 1 | 3 | 0 | 0 | 0 | 3 | 1 | 2 | 3 | |
| 6.1.Environmental warning environmental prevention | Sustainable drains (SUDs) | MA | ME | MY | 3 | 2 | 3 | 0 | 1 | 0 | 3 | 0 | 0 | 0 | 3 | 1 | 3 | 3 | |
| 6.1.Environmental warning environmental prevention | Resting areas | 0 | ME | MY | 0 | 0 | 0 | 0 | 2 | 1 | 0 | 1 | 1 | 2 | 3 | 3 | 3 | 3 | |
| 6.1.Environmental warning environmental prevention | Smart soils | 0 | 0 | MY | 1 | 1 | 0 | 0 | 0 | 2 | 0 | 3 | 3 | 3 | 0 | 1 | 0 | 3 | |
| 6.1.Environmental warning environmental prevention | Horizontal green infrastructures (Horizontal GI) | MA | ME | MY | 0 | 0 | 0 | 3 | 3 | 3 | 0 | 3 | 0 | 3 | 3 | 1 | 2 | 3 | |
| 6.1.Environmental warning environmental prevention | Urban farming | MA | ME | MY | 2 | 2 | 0 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | |
| 6.2.Integrated green management | Panels with attractor species of Pollinators (Pollinator) | 0 | 0 | MY | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 3 | 0 | 0 | 1 | 0 | 0 | 3 | |
| 6.2.Integrated green management | Vertical green infrastructures (Vertical GI) | 0 | ME | MY | 0 | 0 | 0 | 3 | 3 | 1 | 0 | 0 | 0 | 3 | 3 | 1 | 0 | 3 | |
| 6.2.Integrated green management | Arboreal Interventions | MA | ME | MY | 3 | 3 | 0 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | |
| 6.2.Integrated green | Green pavements | 0 | ME | MY | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 1 | 3 | |



| bRetos | Category NBS | Application Scales | | | ECOSYSTEM SERVICES | | | | | | | | | | | | | Main (3) | Intermediate (2) | Tertiary (1) | | | | | | | | | | | |
|---------------------------------|---|--------------------|----|----|------------------------|-------|---------|---------|------|---------|-----------|------|------|---------|----------|----------|--------|----------|------------------|--------------|---------|--------|-----------|------|--------|------|------|------|------|------|-------|
| | | | | | REGULATION AND SUPPORT | | | | | | PROVISION | | | | CULTURAL | | | | | | | | | | | | | | | | |
| | | Ma | Me | My | by mas | s pre | vention | tion of | logu | ate mat | nd red | ucti | logi | cal con | (Wa | ter avai | and me | Wo | od am | ent al | sen sor | y cult | ural /his | toni | al and | toou | rist | valu | rest | (art | , edu |
| management | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 6.2.Integrated green management | Flood actions | MA | ME | MY | 3 | 3 | 3 | 0 | 1 | 1 | 3 | 0 | 0 | 0 | 3 | 1 | 2 | 3 | | | | | | | | | | | | | |
| 6.2.Integrated green management | Sustainable drains (SUDs) | MA | ME | MY | 3 | 2 | 3 | 0 | 1 | 0 | 3 | 0 | 0 | 0 | 3 | 1 | 3 | 3 | | | | | | | | | | | | | |
| 6.2.Integrated green management | Resting areas | 0 | ME | MY | 0 | 0 | 0 | 0 | 2 | 1 | 0 | 1 | 1 | 2 | 3 | 3 | 3 | 3 | | | | | | | | | | | | | |
| 6.2.Integrated green management | Smart soils | 0 | 0 | MY | 1 | 1 | 0 | 0 | 0 | 2 | 0 | 3 | 3 | 3 | 0 | 1 | 0 | | | | | | | | | | | | | | |
| 6.2.Integrated green management | Pollutants filter | 0 | 0 | MY | 0 | 0 | 3 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | | | | | | | | | | | | |
| 6.2.Integrated green management | Horizontal green infrastructures (Horizontal GI) | MA | ME | MY | 0 | 0 | 0 | 3 | 3 | 3 | 0 | 3 | 0 | 3 | 3 | 1 | 2 | 3 | | | | | | | | | | | | | |
| 6.2.Integrated green management | Urban farming | MA | ME | MY | 2 | 2 | 0 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | | | | | | | | | | | | | |
| 6.2.Integrated green management | Water treatment | MA | 0 | MY | 0 | 0 | 3 | 0 | 0 | 1 | 3 | 0 | 0 | 0 | 1 | 0 | 2 | 3 | | | | | | | | | | | | | |
| 6.3.Citizen identity | Panels with attractor species of Pollinators (Pollinator) | 0 | 0 | MY | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 3 | 0 | 0 | 1 | 0 | 0 | | | | | | | | | | | | | | |
| 6.3.Citizen identity | Arboreal Interventions | MA | ME | MY | 3 | 3 | 0 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | | | | | | | | | | | | | |
| 6.3.Citizen identity | Sustainable drains (SUDs) | MA | ME | MY | 3 | 2 | 3 | 0 | 1 | 0 | 3 | 0 | 0 | 0 | 3 | 1 | 3 | 3 | | | | | | | | | | | | | |
| 6.3.Citizen identity | Resting areas | 0 | ME | MY | 0 | 0 | 0 | 0 | 2 | 1 | 0 | 1 | 1 | 2 | 3 | 3 | 3 | 3 | | | | | | | | | | | | | |



| bRetos | Category NBS | Application Scales | | | ECOSYSTEM SERVICES | | | | | | | | | | | | Main (3) | Intermediate (2) | Tertiary (1) |
|------------------------------------|---|--------------------|----|----|------------------------|------------|---------|----|----|----|-----------|----|----|----|----------|----|----------|------------------|--------------|
| | | | | | REGULATION AND SUPPORT | | | | | | PROVISION | | | | CULTURAL | | | | |
| | | | | | Mass | Prevention | tion of | of | of | of | of | of | of | of | of | of | of | of | of |
| 6.3.Citizen identity | Horizontal green infrastructures (Horizontal GI) | MA | ME | MY | 0 | 0 | 0 | 3 | 3 | 3 | 0 | 3 | 0 | 3 | 3 | 1 | 2 | 3 | |
| 6.3.Citizen identity | Urban farming | MA | ME | MY | 2 | 2 | 0 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | |
| 7.1. Capabilities | Arboreal Interventions | MA | ME | MY | 3 | 3 | 0 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | |
| 7.1. Capabilities | Flood actions | MA | ME | MY | 3 | 3 | 3 | 0 | 1 | 1 | 3 | 0 | 0 | 0 | 3 | 1 | 2 | 3 | |
| 7.1. Capabilities | Sustainable drains (SUDs) | MA | ME | MY | 3 | 2 | 3 | 0 | 1 | 0 | 3 | 0 | 0 | 0 | 3 | 1 | 3 | 3 | |
| 7.1. Capabilities | Resting areas | 0 | ME | MY | 0 | 0 | 0 | 0 | 2 | 1 | 0 | 1 | 1 | 2 | 3 | 3 | 3 | 3 | |
| 7.1. Capabilities | Water treatment | MA | 0 | MY | 0 | 0 | 3 | 0 | 0 | 1 | 3 | 0 | 0 | 0 | 1 | 0 | 2 | 3 | |
| 7.2. Distribution | Panels with attractor species of Pollinators (Pollinator) | 0 | 0 | MY | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 3 | 0 | 0 | 1 | 0 | 0 | 3 | |
| 7.2. Distribution | Vertical green infrastructures (Vertical GI) | 0 | ME | MY | 0 | 0 | 0 | 3 | 3 | 1 | 0 | 0 | 0 | 3 | 3 | 1 | 0 | 3 | |
| 7.2. Distribution | Green pavements | 0 | ME | MY | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 1 | 3 | |
| 7.2. Distribution | Resting areas | 0 | ME | MY | 0 | 0 | 0 | 0 | 2 | 1 | 0 | 1 | 1 | 2 | 3 | 3 | 3 | 3 | |
| 7.2. Distribution | Pollutants filter | 0 | 0 | MY | 0 | 0 | 3 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | |
| 7.2. Distribution | Horizontal green infrastructures (Horizontal GI) | MA | ME | MY | 0 | 0 | 0 | 3 | 3 | 3 | 0 | 3 | 0 | 3 | 3 | 1 | 2 | 3 | |
| 7.2. Distribution | Urban farming | MA | ME | MY | 2 | 2 | 0 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | |
| 7.3.Procedures / Genuine Inclusion | Arboreal Interventions | MA | ME | MY | 3 | 3 | 0 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | |
| 7.3.Procedures / Genuine Inclusion | Green pavements | 0 | ME | MY | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 1 | 3 | |
| 7.3.Procedures / Genuine Inclusion | Resting areas | 0 | ME | MY | 0 | 0 | 0 | 0 | 2 | 1 | 0 | 1 | 1 | 2 | 3 | 3 | 3 | 3 | |
| 7.3.Procedures / Genuine Inclusion | Urban farming | MA | ME | MY | 2 | 2 | 0 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | |



| bRetos | Category NBS | Application Scales | | | ECOSYSTEM SERVICES | | | | | | | | | | | | | Main (3) | Intermediate (2) | Tertiary (1) |
|---|---|--------------------|----|----|------------------------|------------------|---------------|----------------|-----------------|--------------|------------|-----------------------|--------------------|--------|------------------|------------|----------------------------------|------------|------------------|--------------|
| | | | | | REGULATION AND SUPPORT | | | | | | PROVISION | | | | CULTURAL | | | | | |
| | | Ma | Me | My | Loss prevention | Pollution of air | Water quality | Soil fertility | Food production | Raw material | Recreation | Regulation of climate | Water availability | Energy | Waste management | Recreation | Historical and cultural heritage | Recreation | Recreation | |
| 7.4. Recognition of different social groups | Flood actions | MA | ME | MY | 3 | 3 | 3 | 0 | 1 | 1 | 3 | 0 | 0 | 0 | 3 | 1 | 2 | 3 | | |
| 7.4. Recognition of different social groups | Urban farming | MA | ME | MY | 2 | 2 | 0 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | | | |
| 7.4. Recognition of different social groups | Resting areas | 0 | ME | MY | 0 | 0 | 0 | 0 | 2 | 1 | 0 | 1 | 1 | 2 | 3 | 3 | 3 | | | |
| 7.4. Recognition of different social groups | Sustainable drains (SUDs) | MA | ME | MY | 3 | 2 | 3 | 0 | 1 | 0 | 3 | 0 | 0 | 0 | 3 | 1 | 3 | | | |
| 7.4. Recognition of different social groups | Pollutants filter | 0 | 0 | MY | 0 | 0 | 3 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | |
| 7.4. Recognition of different social groups | Horizontal green infrastructures (Horizontal GI) | MA | ME | MY | 0 | 0 | 0 | 3 | 3 | 3 | 0 | 3 | 0 | 3 | 3 | 1 | 2 | | | |
| 7.4. Recognition of different social groups | Vertical green infrastructures (Vertical GI) | 0 | ME | MY | 0 | 0 | 0 | 3 | 3 | 1 | 0 | 0 | 0 | 3 | 3 | 1 | 0 | | | |
| 7.4. Recognition of different social groups | Arboreal Interventions | MA | ME | MY | 3 | 3 | 0 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | | | |
| 7.4. Recognition of different social groups | Green pavements | 0 | ME | MY | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 1 | | | |
| 7.4. Recognition of different social groups | Panels with attractor species of Pollinators (Pollinator) | 0 | 0 | MY | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 3 | 0 | 0 | 1 | 0 | 0 | | | |
| 7.4. Recognition of different social groups | Smart soils | 0 | 0 | MY | 1 | 1 | 0 | 0 | 0 | 2 | 0 | 3 | 3 | 3 | 0 | 1 | 0 | | | |



| bRetos | Category NBS | Application Scales | | | ECOSYSTEM SERVICES | | | | | | | | | | | | | | | Main (3) | Intermediate (2) | Tertiary (1) |
|---|---|--------------------|----|----|------------------------|------------------------|-----------------------|--------------------|----------------------------|--------------------|-----------------|--------------|------------|------------|-----------|--------|----------------------------------|------------|-----------|----------|------------------|--------------|
| | | | | | REGULATION AND SUPPORT | | | | | | | PROVISION | | | | | CULTURAL | | | | | |
| | | Ma | Me | My | Loss prevention | Reduction of pollution | Regulation of climate | Reduction of noise | Reduction of air pollution | Water availability | Food and energy | Raw material | Recreation | Well-being | Education | Health | Historical and cultural heritage | Recreation | Education | | | |
| 7.4. Recognition of different social groups | Water treatment | MA | 0 | MY | 0 | 0 | 3 | 0 | 0 | 1 | 3 | 0 | 0 | 0 | 1 | 0 | 2 | 3 | | | | |
| 8.1. Reduce risks in vulnerable communities | Vertical green infrastructures (Vertical GI) | 0 | ME | MY | 0 | 0 | 0 | 3 | 3 | 1 | 0 | 0 | 0 | 3 | 3 | 1 | 0 | 3 | | | | |
| 8.1. Reduce risks in vulnerable communities | Arboreal Interventions | MA | ME | MY | 3 | 3 | 0 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | | | | |
| 8.1. Reduce risks in vulnerable communities | Green pavements | 0 | ME | MY | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 1 | 3 | | | | |
| 8.1. Reduce risks in vulnerable communities | Sustainable drains (SUDs) | MA | ME | MY | 3 | 2 | 3 | 0 | 1 | 0 | 3 | 0 | 0 | 0 | 3 | 1 | 3 | 3 | | | | |
| 8.1. Reduce risks in vulnerable communities | Horizontal green infrastructures (Horizontal GI) | MA | ME | MY | 0 | 0 | 0 | 3 | 3 | 3 | 0 | 3 | 0 | 3 | 3 | 1 | 2 | 3 | | | | |
| 8.2. Encourage physical activities | Arboreal Interventions | MA | ME | MY | 3 | 3 | 0 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | | | | |
| 8.2. Encourage physical activities | Green pavements | 0 | ME | MY | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 1 | 3 | | | | |
| 8.2. Encourage physical activities | Resting areas | 0 | ME | MY | 0 | 0 | 0 | 0 | 2 | 1 | 0 | 1 | 1 | 2 | 3 | 3 | 3 | 3 | | | | |
| 8.3. Mental health and well-being | Panels with attractor species of Pollinators (Pollinator) | 0 | 0 | MY | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 3 | 0 | 0 | 1 | 0 | 0 | 3 | | | | |
| 8.3. Mental health and well-being | Vertical green infrastructures (Vertical GI) | 0 | ME | MY | 0 | 0 | 0 | 3 | 3 | 1 | 0 | 0 | 0 | 3 | 3 | 1 | 0 | 3 | | | | |
| 8.3. Mental health and well-being | Arboreal Interventions | MA | ME | MY | 3 | 3 | 0 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | | | | |
| 8.3. Mental health | Sustainable drains (SUDs) | MA | ME | MY | 3 | 2 | 3 | 0 | 1 | 0 | 3 | 0 | 0 | 0 | 3 | 1 | 3 | 3 | | | | |



| bRetos | Category NBS | Application Scales | | | ECOSYSTEM SERVICES | | | | | | | | | | | | | Main (3) | Intermediate (2) | Tertiary (1) |
|----------------------------------|--|--------------------|----|----|------------------------|----|----|---|--------------------------------------|--|---|---|---|---|---|----------|---|----------|------------------|--------------|
| | | | | | REGULATION AND SUPPORT | | | | | | PROVISION | | | | | CULTURAL | | | | |
| | | | | | Ma | Me | My | (by mas s pre ven tion tion of legi late mat red ucti logi cal con | (Wa ter ava il and me | Wo od am ent al sen sor y | cult ural /his ton al and tou rist valu rest (art , edu | | | | | | | | | |
| and well-being | | | | | | | | | | | | | | | | | | | | |
| 8.3.Mental health and well-being | Resting areas | 0 | ME | MY | 0 | 0 | 0 | 0 | 2 | 1 | 0 | 1 | 1 | 2 | 3 | 3 | 3 | 3 | | |
| 8.3.Mental health and well-being | Pollutants filter | 0 | 0 | MY | 0 | 0 | 3 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | | |
| 8.3.Mental health and well-being | Horizontal green infrastructures (Horizontal GI) | MA | ME | MY | 0 | 0 | 0 | 3 | 3 | 3 | 0 | 3 | 0 | 3 | 3 | 1 | 2 | 3 | | |
| 8.3.Mental health and well-being | Urban farming | MA | ME | MY | 2 | 2 | 0 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | | |
| 8.3.Mental health and well-being | Water treatment | MA | 0 | MY | 0 | 0 | 3 | 0 | 0 | 1 | 3 | 0 | 0 | 0 | 1 | 0 | 2 | 3 | | |

Table 6.12: Potential contributions of NBS to Ecosystem Services and Territorial Supply



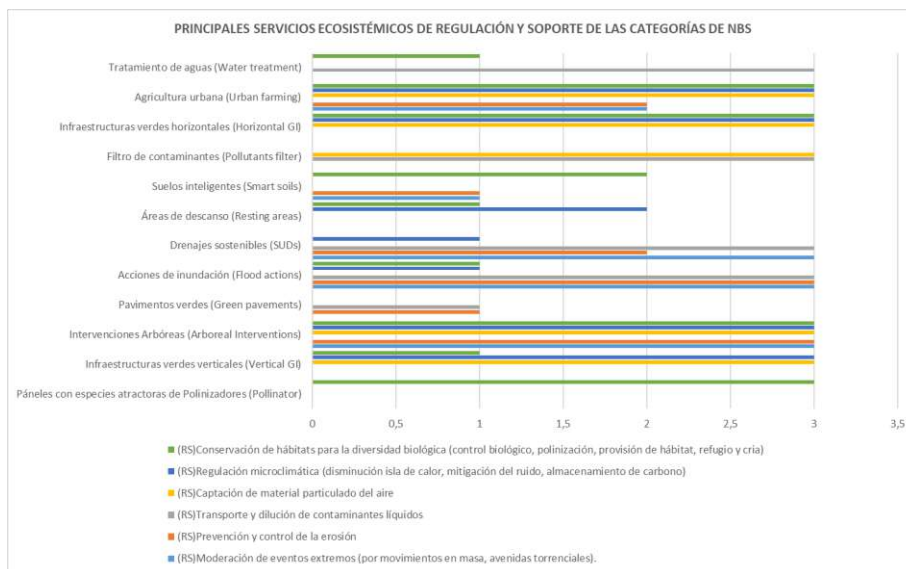


Figure 6.6: Main regulatory and support Ecosystem Services

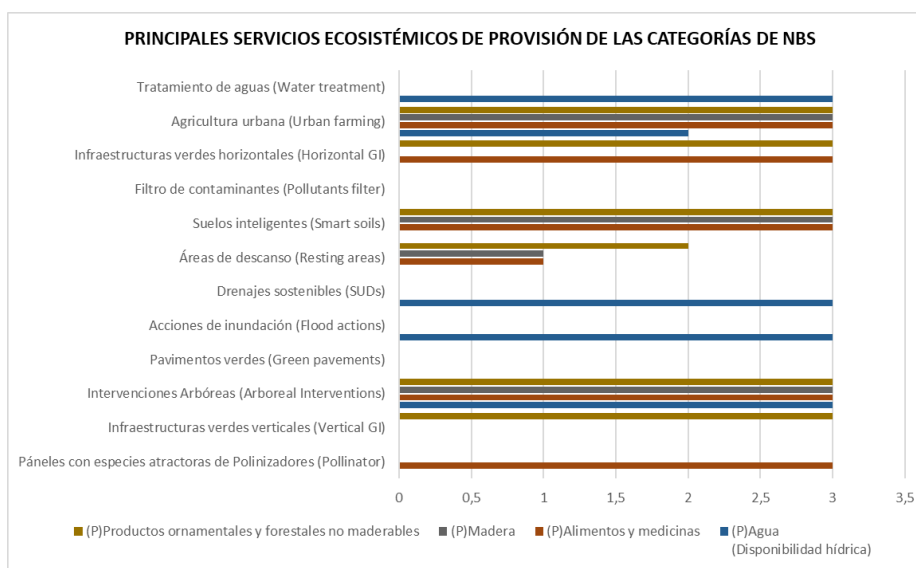


Figure 6.7: Main provision Ecosystem Services

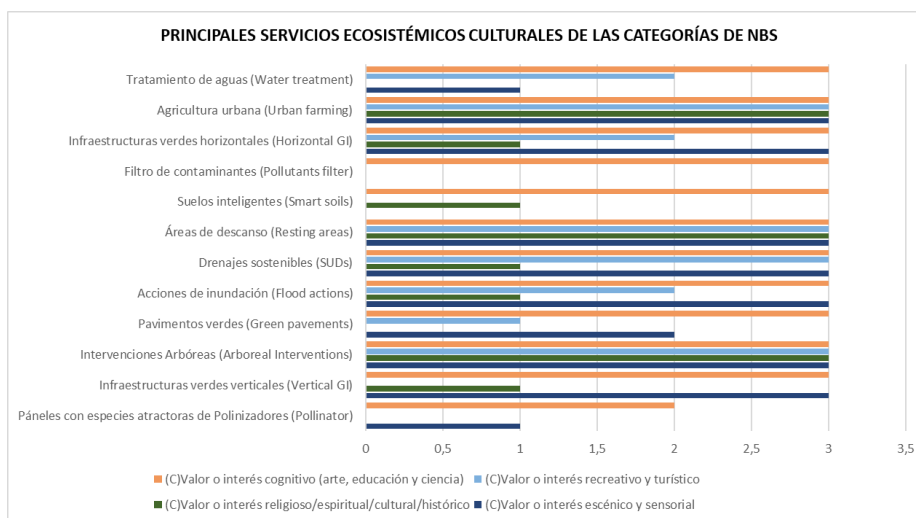


Figure 6.8: Main cultural Ecosystem Services



Annex 6: Analysis of key stakeholders and potential roles.

Administrative Department of Planning.

To encourage the integral development of the municipality in the long, medium and short term, through the direction, coordination and articulation of public policies, plans and programs in the different dimensions of social, economic, physical-environmental, financial, political and institutional development, through the definition of the city and occupation model and the institutional strategic platform for the Municipal Administration, depending on the fulfillment of the purposes of the state and its financial sustainability, attending to the diagnoses, trends, government commitments and processes of concertation between authorities, actors and planning instances, aimed at integral human development.

- Coordinate and direct the follow-up to the budget execution, Development Plan and its management instruments such as: action plan and indicative plan, concerning the Department in coordination with the different dependencies.

Subdirectorate of Social and Economic Planning

Municipal and Local Development Planning Unit (Coordinate the planning processes of municipal and local development, within the framework of the Municipal Planning System, through articulation with the dependencies of the Administrative Department of Municipal Planning and with the different actors involved, seeking to improve the levels of participation, articulation and legitimation).

Unit of Planning and Social Policy (Carry out studies and research on aspects of social, economic, demographic, physical-spatial, environmental nature, and manage information systems for the socioeconomic classification of people, in harmony with the guidelines of the national government).

Subdirectorate of Information and Strategic Evaluation

Strategic Information Production Unit (Consolidate sectoral information through strategic and city indicators. To carry out studies and research on aspects of a social, economic, demographic, physical-spatial and environmental nature).

Municipal Development Planning Monitoring Unit (Monitor and evaluate the Development Plan, through the instruments defined by law).

Strategic Monitoring Unit to the Territorial Planning Plan (Carry out the monitoring and evaluation of the Territorial Planning Plan, in coordination with the Subdirectorate of Territorial Planning and with the missionary leaders responsible for its execution, through the instruments defined by law and generate strategic information and methodological direction for the definition of the system of indicators of the Management Plan).

Subdirectorate of Territorial and Strategic Planning of the City

Territorial Planning Unit (Carry out studies and thematic special plans such as: main ecological structure, public space, risk management and climate change, mobility and transport, public space, real estate heritage, special zonal and corregimental plans, among others, that guarantee the updating of the systems that structure the territory that allow the analysis of economic, social, environmental and institutional impacts for the definition of urban policies



and regulations within the framework of the Integral Management System according to the guidelines defined by the entity).

Unit for the Formulation of Management Instruments (Coordinate the formulation and management of the different instruments of land intervention, as well as the management and formulation of urban proposals in accordance with the Territorial Planning Plan and current regulations).

Strategic Projects Unit (Formulate and prioritize strategic projects that consolidate the territorial model through the execution program of the Territorial Planning Plan articulated with the complementary planning instruments).

Secretariat of Physical Infrastructure. It is in charge of designing, building and conserving the infrastructure for public use and the buildings and facilities of the Municipality of Medellín, propending for the protection of the environment and sustainable development.

Operational Undersecretary

- Guarantee quality in the process of construction and maintenance of road infrastructure, physical infrastructure and buildings and facilities owned by the Municipality, both in its administrative and technical aspect.
- Establish geographical areas and programs that guarantee their conservation, protection, maintenance and promotion of green spaces, as well as actions aimed at the construction, repair, remodeling, maintenance, furnishing and care of public parks and passive recreation areas of the Municipality of Medellín.

Ministry of Education. It is a dependency of the central level, which will have as its responsibility to guarantee the access and permanence of girls, boys, youth and adults of Medellín to an educational system characterized by quality, efficiency, effectiveness and relevance, which forms citizens committed to their city, their region and the country, for the construction of a democratic, inclusive, equitable and productive society.

- Direct and coordinate the provision of the educational service through the advice and comprehensive technical assistance to the educational establishments of initial, preschool, basic, middle and extra-age education of the Municipality of Medellín.
- Plan, budget and coordinate with the Secretariat of Physical Infrastructure the needs of equipment endowment identifying the requirements of physical infrastructure for the different programs and projects that must be prioritized, implemented and executed within the framework of the Development Plan and its articulation with the Territorial Planning Plan and its complementary instruments.

Undersecretary of Educational Service Provision:

- Promote the development of research, pedagogical innovation and scientific and technological production, from school, for the sociocultural construction of knowledge, as a transformative action of local contexts and learning processes.
- Coordinate with the Ministry of the Environment the definition of plans, programs and projects of training and education to improve environmental management and the responsible use of renewable natural resources and promote a culture of respect for natural heritage.



DAGR. Formulate, execute, monitor and evaluate policies, strategies, plans, programs, regulations and permanent actions for knowledge and risk reduction and for disaster management of the city of Medellín, with the explicit purpose of contributing to the safety, well-being, quality of life of people and sustainable development.

Subdirectorato de Knowledge and Disaster Risk Reduction

- Carry out the identification of risk scenarios that facilitate the understanding and prioritization of problems, as well as the formulation and execution of the required intervention actions, in their different factors (scenarios for threatening phenomena, type of elements or goods exposed, type of damage, by social group, by economic activities, by social activities, and by operation of large works).
- To promote the harmonization and articulation of actions for territorial planning, environmental management, adaptation to climate change and risk management of emergencies and disasters.
- To guide and promote the actions of communication of the existence, scope, and dimension of the risk to the municipal system and society in general.
- Guide and promote corrective intervention actions in the existing conditions of vulnerability and threat.
- Guide and promote prospective intervention to avoid new risk conditions.

Secretariat of Communications. It is a dependency of the Mayor's office that will be responsible for defining communications policies, as well as the planning, design, coordination, execution and evaluation of informational, corporate, institutional and mobilization strategies of the Municipal Administration.

- Direct, coordinate and accompany the dependencies of the Municipal Administration in the planning, design, execution and evaluation of communication strategies, of an informative, corporate, institutional and mobilization nature.
- Plan, design and coordinate strategies for information communication, organizational communication and communication for development.
- 16. Coordinate the communications strategy for the formulation, implementation and execution of the Municipal Development Plan and the Territorial Planning Plan and its complementary instruments.

Secretariat of Citizen Culture. It is a dependency of the central level, who has as its responsibility, to guarantee the conditions for the effective, progressive and sustainable exercise of the rights to culture, of the inhabitants of the Municipality of Medellín, as well as to strengthen the cultural, artistic and patrimonial fields.

- Coordinate corporate strategies and policies for the implementation of citizen culture relationships that integrate the public with the private.
- Strengthen an organized, free, autonomous and supportive citizenry, capable of coexisting in heterogeneity, multiculturalism and diversity to peacefully transform its conflicts.
- Promote the exercise of civil and cultural rights as guarantors of human dignity, coexistence, respect for life and the recognition of identities for current and future generations.



Undersecretary of Cultural Citizenship

- Promote the quality of human development and peaceful coexistence through civic culture in the various actors of the city.
- Generate permanent pedagogical zones for dialogue and cultural intermediation.

Undersecretary of Art and Culture

- To promote and promote manifestations and cultural expressions typical of a diverse multi-ethnic and multicultural city.
- Plan and execute the permanent cultural agenda in cultural facilities, community events and city events.
- Promote cultural practices and the transfer of knowledge.

Undersecretary of Libraries, Reading and Heritage

- Guarantee free access to information, knowledge, thought and culture.
- Implement strategies for the dissemination and conservation of tangible and intangible cultural heritage.

Secretariat of Economic Development. It is a dependency of the central level that has as its responsibility to strengthen productivity, competitiveness and sustainability through mechanisms of business development, associativity, labor intermediation, social-public-private alliances, internationalization and innovation, in order to favor the economic development of the city and the improvement of the quality of life of its inhabitants.

Undersecretary of Rural Development

- Develop strategies and activities of support and accompaniment in the rural sector of the Municipality of Medellín for micro, small and medium agricultural producers.
- Guarantee access and participation in the plans, programs and projects that exist from the Municipal Administration and that seek to increase their productivity, profitability and competitiveness. This undersecretariat includes the UMATA (Municipal Unit for Agricultural Technical Assistance), which provides the public service of agricultural extension to specifically agricultural producers in the rural area of the municipality.

Undersecretariat for Business Creation and Strengthening

- Support for innovative ideas with growth capacity according to market demand, and the promotion of Economic Development projects of the Local Development Plans of the communities

Undersecretary of Tourism

- Planning of the tourism development of the city from the governmental sphere, with special attention to strengthening the competitiveness of the actors of the tourism sector in the city and the promotion of the destination.

Secretariat of Management and Territorial Control. It exercises territorial management and control, physically, legally and economically identifies public and private real estate; guarantees the provision of public services at home and non-residential and exercises urban



control, through the follow-up and monitoring of the model of occupation of the territory defined in the Territorial Planning Plan.

- Exercise urban monitoring and control, based on the urban planning regulations and the guidelines established in the Territorial Planning Plan, taking into account the legal and regulatory competences.
- Carry out inspection, surveillance and control activities for the execution of urban and construction projects in coordination with the competent entities and authorities.
- Monitor and control the actions of urban curators in the application of urban regulations.
- Lead the fulfillment of the competences in matters of urban control that correspond to the Municipality, in accordance with the provisions of higher regulations and the Territorial Planning Plan.
- Lead the process of liquidation and verification of compliance with urban obligations.
- Exercise urban surveillance and control during the execution of the works, in order to ensure compliance with urban planning licenses, as well as control informal construction in accordance with the regulatory regulations contained in the Territorial Planning Plan.
- Lead the cadastral system of the Municipality of Medellín, which is responsible for identifying, preparing and maintaining the inventory of real estate belonging to the State and individuals, duly updated and classified in order to achieve their correct physical, legal and fiscal identification.
- Develop the policies and plans of the Municipality of Medellín in the field of cartography and cadastre, through the production, analysis and dissemination of cadastral and georeferenced environmental information, in order to support the planning and territorial planning processes.

Secretariat of Security and Coexistence. The objective is the planning, management, articulation, development, implementation and evaluation of all actions aimed at strengthening and improving security in the Municipality of Medellín, through the execution of public policies and administrative strategies for the exercise of authority and territorial control, while preserving institutionality and public order, protecting the rights of citizens and reducing crime rates.

Secretariat of Mobility. Plans, regulates and controls the aspects related to land transport activity, pedestrian and vehicular circulation, in accordance with the model of social and economic development of the city, providing services that meet the needs of the user and promoting the culture of road safety and a healthy environment.

- Direct, establish policies, plans, programs and projects in the field of transit and transport, aimed at improving mobility in conditions of safety, comfort, sustainability and accessibility.
- Prioritize the programs and projects necessary to have the infrastructure, equipment and furnishing that allow the development of transport in the city, connecting it regionally with the rest of the country.



- Design and establish mobility plans and programs within the framework of the Territorial Planning Plan that allow the fulfillment of the strategic objectives of the entity and functions of the dependency.
- Coordinate, regulate and develop programs that lead to the best administration and use of the city's road network.
- To guide the activities of the unit based on principles of citizen education in mobility, respect for the environment and public space.
- Contribute to the rationalization of public space, giving priority to the pedestrian.
- Plan, budget and coordinate with the Secretariat of Physical Infrastructure the needs of equipment endowment identifying the requirements of physical infrastructure for the different programs and projects that must be prioritized, implemented and executed within the framework of the Development Plan and its articulation with the Territorial Planning Plan and its complementary instruments.

Secretariat of Citizen Participation. Define Citizen Participation policies, as well as strengthen active citizenship, through strategies of mobilization, training, organization and democratic participation, to contribute to integral human development, to the dynamization of a participating society with a political culture, capable of transforming the city with equity, inclusion, coexistence and transparency.

- Direct the implementation of policies, plans, programs, training projects and generation of political culture for democratic citizen participation that lead to the qualification and emergence of leadership.
- Direct the strengthening of civil society organizations and networks, through the implementation of promotion, accompaniment and control actions, for the consolidation of the social fabric and the management of local and municipal development.
- Coordinate the exercise of citizen participation and mobilization, through the dynamization of democratic scenarios that affect the public management of development, social control and good governance to build an inclusive, equitable and transparent city.

Ministry of Health. Direct, inspect, monitor and control the general system of social security in health at the local level, identifying resources and creating the conditions that guarantee the coverage and access of users to health services, within a framework of humanism, efficiency, effectiveness, quality and sustainable development, promoting social and community participation, the integration of the network of services and individual and collective actions to promote health and prevent disease.

- Formulate, execute and evaluate plans, programs and projects in health, in harmony with the policies and provisions of the national and departmental order.
- Promote mechanisms for adequate social participation and the full exercise of the duties and rights of citizens in the field of health and social security in health.
- Improve the health of the community by carrying out actions to promote health, prevent disease and the inspection, surveillance and control of risk factors.



Ministry of the Environment. Define environmental policies, as well as the planning, design, coordination, execution and evaluation of informational, corporate, institutional and mobilization strategies of the Municipal Administration.

- Direct and coordinate with the other dependencies, decentralized entities and environmental authorities, the formulation and implementation of the mitigation and adaptation plan to municipal climate change, taking into account the guidelines of the Territorial Planning Plan, the policies established by the entity and the regulations in force.
- Lead the implementation of national, regional and local policies of the environmental dimension and renewable natural resources with the different actors.
- Implement actions of reforestation, assisted natural regeneration, ecological tourism, fencing and delimit, for the protection of water resources.
- Advance the actions aimed at generating, recovering, restoring and maintaining the main ecological structure.
- Participate in the formulation and implementation of the complementary instruments to the Territorial Planning Plan related to the protection and conservation of natural resources.
- Manage with the competent agencies the acquisition of land, in favor of the conservation, preservation and recovery of natural resources and incorporate the National Policy for Interior Wetlands of Colombia, established in Law 357 of 1997 or in which it modifies or replaces it.
- Promote the maintenance, operation, development and technical, scientific and social strengthening of the Early Warning System of Medellín and its neighboring region – SIATA, in coordination with the DAGRD.
- Promote the legal provisions necessary for the surveillance, preservation and defense of the ecological heritage of the municipality.
- Direct the formulation, execution and monitoring of the Municipal Environmental Plan (PAM) in harmony with the guidelines established by Municipal Planning and the Ministry of Environment and Sustainable Development.
- Lead the formulation, review, consultation and monitoring of environmental issues of the Territorial Planning Plan.
- Direct the Environmental Management System of Medellín (SIGAM), as a strategic tool for the harmonization of environmental management.
- Adopt the plans, programs and projects for the conservation, recovery and protection of renewable natural resources and improvement of environmental conditions, as well as lead the preparation of the plans that according to the competence corresponds to the Municipality of Medellín in environmental matters.
- Lead the Environmental Information System of Medellín (Siamed).
- Collaborate with the Regional Autonomous Corporation and the Metropolitan Area of the Aburrá Valley, in the elaboration of regional plans and in the execution of programs, projects and actions necessary for the conservation of renewable natural resources and the improvement of environmental conditions.



- Act subject to the legal distribution of powers so that the functions of control and surveillance of the environment and renewable natural resources, assigned to the municipal instances, are fulfilled.
- Direct the activities related to the integral management of the Municipal Orographic System, according to the provisions of the Territorial Planning Plan.
- Lead the achievement of external resources of the international, national and regional order, in order to meet the objectives of the secretariat.
- Define policies, plans and programs aimed at research, for the conservation, improvement, promotion, valuation and sustainable use of renewable natural resources and environmental services of the municipality.
- Define and agree on training and education plans, programs and projects to improve environmental management and the responsible use of renewable natural resources and promote a culture of respect for natural heritage.
- Plan, budget and coordinate with the Secretariat of Physical Infrastructure the needs of equipment endowment, identifying the requirements of physical infrastructure for the different programs and projects that must be prioritized, implemented and executed within the framework of the Development Plan and its articulation with the Territorial Planning Plan and its complementary instruments.

Secretariat of Social Inclusion and Family. It involves the formulation, articulation, coordination and implementation of social strategies and policies aimed at the promotion, protection, restitution and guarantee of the rights of the different population groups, for the improvement of the quality of life.

- Coordinate and articulate with public and private governmental and non-governmental entities, intersectoral and inter-institutional management for the prevention, promotion, research, diagnosis and execution of social programs aimed at population groups at social risk.

Undersecretariat of Population Groups.

- Develop and implement public policies aimed at restoring the rights of population groups, seeking greater and better conditions of participation, equity and social inclusion within the framework of co-responsibility.
- Promote the integral human development of the population at social risk, facilitating their autonomy and social inclusion, contributing to improve the quality of life.
- Articulate and coordinate with public and private entities the intersectoral and inter-institutional management in the execution of social programs and projects aimed at the promotion, prevention, mitigation and overcoming of the social risk of population groups.

Agency for landscape management, heritage and public-private partnerships. Manage and promote actions that guarantee the qualification, sustainability and maintenance of the Public and Collective System defined in the POT, focusing on the public space of recreation and encounter, landscape, heritage and equipment. In addition, it becomes responsible for promoting the generation of resources through the implementation of the financial



instruments defined in the TEP and encouraging the incorporation of private capital into investment projects for public benefit.

- Promote the incorporation of private capital to public benefit investment projects that seek the integral improvement in the living conditions of the inhabitants of the city, through the incorporation of strategies, instruments and mechanisms of relationship between the Municipality of Medellín and its decentralized entities with private entities, generating the necessary trust for success.
- The Agency through the linking of private capital will materialize the provision of public goods and related services that involve the retention and transfers of risks between the parties, payment mechanisms related to the availability and level of infrastructure services and / or services.
- Implement the formulation of public investment policy in physical infrastructure projects, Transport and Mobility, Public Buildings, Housing and Environmental Issues, Drinking Water, Solid Waste, Energy, Telecommunications, Social, Education and Health, in which private capital is included.

Subdirectorato de PPP Management

- Contribute to meet the demand for infrastructure, for which it examines conventional models through new approaches that link the public and private sector to generate an adequate provision of the service and guarantee its sustainability.
- It structures, evaluates and promotes integral projects that include the design, construction, financing, operation and maintenance of social and productive infrastructure. It works in sectors such as education, health, urban renewal and housing, among others.

Subdirectorato de Real Estate Management

- Carry out an adequate management of the fiscal real estate owned by the Municipality of Medellín, through real estate services focused on the economic use of real estate, facilitating the linking of private capital for the generation of resources for the qualification, sustainability and maintenance of the same.

Subdirectorato de Landscape and Heritage

- Guarantee the qualification, sustainability and maintenance of the public and collective system, through the operation of some financing instruments of the Territorial Planning Plan (POT), such as the Economic Use of Public Space and the Transfers of Construction Rights with Environmental or Patrimonial Destination
- Generate initiatives of intervention and qualification of the urban landscape in which there is a shared investment between the public and private sectors.

Instituto de Deportes y Recreación de Medellín -INDER. Promote sports, physical activity, recreation and the use of free time, through the offer of programs, in spaces that contribute to the improvement of citizen culture and the quality of life of the inhabitants of the municipality of Medellín. To people of formation of citizen culture and social transformation, leader in the development of sport, physical activity and recreation, dynamic, highly efficient and the main



reference in the projection, construction and administration of sports, recreational and physical activity infrastructure for an equitable, inclusive and respectful city of life.

- Efficiently manage financial, physical, technological, natural resources and human talent. We allocate resources to ensure compliance with institutional objectives.
- Promote the protection of the environment and improve our environmental performance, making efficient use of natural resources, reducing pollution and generating environmental culture in our staff and users
- Comply with the environmental regulatory requirements in force according to the activities and operations of the institute.

Subdirectorate of sports and recreational spaces

- Organize and identify, in coordination with the Deputy Director of Sports Development, the needs of construction, maintenance and adaptation of the sports and recreational scenarios owned by the municipal administration, and report to the Director of the Institute in order to stipulate their prioritization.
- Define and project the environmental management plan, which must be put into practice in the construction, adaptation and maintenance of all sports and recreational scenarios that are in charge of the institute.
- Direct other public entities in the implementation, construction, adaptation or maintenance of sports scenarios, ensuring that they adapt to the criteria of quality, compliance with technical-sports standards according to each discipline and, in general, ensuring that they are carried out according to the technical standards of construction and earthquake resistance.

Social Institute of Housing and Habitat of Medellín - ISVIMED. Decentralized institute of the Mayor's Office of Medellín focused on the population in situations of poverty, social vulnerability and precariousness of the habitat. Provide housing solutions involving public, private and community entities in the processes of management, self-management and execution of comprehensive housing and habitat projects. Our field of action is both urban and rural, at the local and regional level.

- Manage social housing plans in the Municipality of Medellín, implementing a comprehensive and coordinated policy with public, private and community actors that guarantees the right to habitat and decent housing and improves the quality of life of lower income family groups.

Director general construction

- Develop directly or indirectly, all activities related to strategic planning for the implementation of the housing plan.
- Develop directly or indirectly all activities related to the promotion and development of housing projects of social interest, in order to obtain from public and private sources resources and inputs for their execution.



- Receive, administer, and enable, when appropriate, fiscal properties of the nation, the department and its municipalities or decentralized entities, which may be used for housing of social interest.
- Sign cooperation agreements with the private sector and other agents of the housing system for the development of comprehensive housing and habitat actions in the urban and rural municipal and regional context.

Subdirectorate of Housing Endowment and Habitat

- Direct and formulate institutional policies and adopt plans, programs and projects, aimed at administering the Activities of the Institute.
- Direct and develop, from the technical field and within the missionary objectives of the Institute, the planning, management and execution of the projects of construction of new housing, improvement and recognition, acquisition of land, resettlements and real estate management of the Institute.

Valorization Fund of the Municipality of Medellín - Fonvalmed. Entity responsible for the formulation and execution of projects of public interest through the collection and investment of the valorization contribution. Attached to the Ministry of Finance. Its purpose is to administer the assets, income and other income originated in the execution of public works financed totally or partially through the system of the valuation contribution.

Urban Development Company – EDU. Development, execution, advice and management of urban and real estate plans, programmes and projects at the municipal, departmental, national and international levels. Its mission is to transform the habitat through the formulation, design, execution, advice and consulting of urban projects that contribute to the development of the territory and the improvement of the quality of life, working in articulation with the people.

- Formulate and coordinate the social, legal, technical, urban and real estate management of those projects entrusted to it; being able, in addition, to design, promote, build, sell, finance, manage, exercise control and the intervener of these; as well as applying the instruments of land management and financing of projects established in the law.
- Develop urban actions of subdivision, urbanization and construction of real estate, according to the management procedures and forms of execution oriented by the urban and / or rural component of the territorial planning plan and its complementary rules.
- When the realization of the urban actions generates greater value for the properties, it may establish the participation in surplus value in the terms established by law, as well as the definition of the land management and financing instruments necessary to execute each project, especially those related to the definition, structuring and execution of the equitable distribution of burdens and benefits, within the framework of the law.



- To act as a real estate or land bank for the entity entrusted to it with this function, in accordance with the powers conceived in the law for its administration, management and control.
- It may administer and manage the resources from the compensated payment of urban obligations and the Economic Use of Public Space, and other income received by the entity in charge of collection and entrusted to it with said function.

Corregimientos Management

- Generate coordination spaces with the different dependencies of the central level and decentralized entities, to bring the institutional offer to the inhabitants of the corregimientos.
- Manage, articulate and accompany the integral transformation of the corregimientos in search of adequate conditions of urban infrastructure for the improvement of the environment and materialization of the sustainable city model.
- Articulate with the Ministry of Economic Development actions that allow to boost the economy of the corregimientos.
- Implement and execute the policies and guidelines that guide the Territorial Planning Plan within the scope of its functions.

Metropolitan Area of the Aburrá Valley. Administrative entity, framed in the associative schemes, which seeks to lead the sustainable and equitable development of the territory, through articulated and concerted actions with the municipal entities for the planning of the territorial and environmental planning of the region, the rationalization in the provision of public services, the execution of works of common interest, the exercise of urban environmental authority and mobility, contributing to the improvement of the quality of life of the entire population.

- Program and coordinate the harmonious, integrated and sustainable development of the municipalities that make it up; collecting the elements related to integral human development and territorial planning and planning, economic development and social management.
- Lead the construction of metropolitan infrastructure of public spaces and social facilities, housing and its surroundings.
- To be an authority and articulator of environmental quality and sustainable development covering matters of care and protection, management, surveillance and environmental control and risk management.

Corantioquia. Corporate entity of a public and national nature, with its own assets, legal personality and administrative and financial autonomy, composed of 80 municipalities whose territories are located in the slopes and tributary lands of Cauca Antioquia and the basin of the Medellín River, Porce, Nechí, as well as part of the Magdalena of Antioquia. It executes policies, plans, programs and projects on the environment and renewable natural resources, and applies the legal provisions in force on their disposal, management and use, in accordance with the regulations, guidelines and guidelines issued by the Ministry of the Environment.



- To implement the national policies, plans and programmes in environmental matters defined by the law approving the National Development Plan and the National Investment Plan or by the Ministry of the Environment, as well as those of the regional order entrusted to it in accordance with the law, within the scope of its jurisdiction;
- Exercise the function of maximum environmental authority in the area of its jurisdiction, in accordance with the higher standards and in accordance with the criteria and guidelines drawn up by the Ministry of the Environment;
- Coordinate the process of preparation of environmental development plans, programs and projects to be formulated by the different agencies and integrated entities of the National Environmental System (SINA) in the area of their jurisdiction and in particular, advise the Departments, districts and Municipalities of their territorial understanding in the definition of environmental development plans and in their programs and projects in the field of protection of the environment and renewable natural resources
- Participate with the other competent bodies and entities within the scope of their jurisdiction, in the planning and territorial planning processes so that the environmental factor is taken into account in the decisions that are adopted;
- Exercise the functions of evaluation, control and environmental monitoring of the uses of water, soil, air and other renewable natural resources, which shall include the dumping, emission or incorporation of liquid, solid and gaseous substances or waste, to waters in any of their forms, to air or soils, as well as discharges or emissions that may cause damage or endanger the normal sustainable development of resources renewable natural or prevent or hinder their use for other uses, these functions include issuing the respective environmental licenses, permits, concessions, authorizations and laissez-passer;
- Impose and execute, without prejudice to the powers conferred by law on other authorities, the police measures and sanctions provided for by law, in case of violation of the rules of environmental protection and management of renewable natural resources and demand, subject to the relevant regulations, the reparation of damages caused;
- Promote and execute works of irrigation, drainage, defense against floods, regulation of water channels and streams, and land recovery that are necessary for the defense, protection and adequate management of watersheds of the territory of its jurisdiction, in coordination with the managing and executing agencies of the National Land Adequacy System, in accordance with the corresponding legal provisions and technical provisions; Execute, administer, operate and maintain in coordination with territorial entities, projects, sustainable development programs and infrastructure works whose realization is necessary for the defense and protection or for the decontamination or recovery of the environment and renewable natural resources;
- Carry out activities of analysis, monitoring, prevention and control of disasters, in coordination with the other competent authorities, and assist them in environmental aspects in the prevention and attention of emergencies and disasters; carry out with



the municipal or district administrations programs to adapt urban areas in high-risk areas, such as erosion control, channel management and reforestation;

- Acquire privately owned and patrimonial assets in public law entities and advance before the competent judge the expropriation of goods, once the direct negotiation stage has been completed, when this is necessary for the fulfillment of their functions or for the execution of works or projects required for the fulfillment of the same, and to impose any easements that may be applicable, in accordance with the law

Botanical Garden of Medellín. Non-profit foundation governed by private law. We create experiences of encounter and coexistence for the city, integrated into research, conservation, education and culture strategies associated with biodiversity and the relationship of the human being with the natural environment.

- It actively participates in the process of landscape beautification of different public spaces of the city, from the planting and maintenance of plant material.

EPM. It has a history to tell, with figures and facts of a social and environmental responsibility that gives meaning to its origin, its development and its business strategy. Organized under the figure of "industrial and commercial company of the State", owned by the Municipality of Medellín, EPM prints the highest international quality standards to the services it provides: electricity, gas by network, water and sanitation.

Various Companies - EMVARIAS. Organization in charge for 56 years of the provision of the public service of home cleaning and its complementary activities in the city of Medellín. Its trajectory, expertise and innovation in the framework of the integral management of solid waste, makes it an emblematic Antioquia company, recognized for the quality of the service it provides. Structured as a public limited company, it is part of the EPM Group.

- Provision of the public cleaning service within the framework of the integral management of solid waste.
- Provision of ordinary and special public cleaning services and related and complementary activities provided for in Law 142 of 1994.
- Provision of services of handling, collection, treatment, transport, final disposal and use of ordinary, special, industrial and hazardous waste inside and outside the national territory.
- The specialization of all kinds of products, goods or services for the benefit or interest of users of public household services or complementary activities that constitute the main corporate purpose of the company.
- Participation in activities for the promotion of innovation, scientific research and technological development in the fields related to the public service that constitutes its object.

Medellin Metro. Decentralized entity by services of the municipal order, constituted as a public limited liability company, subject to the regime provided for industrial and commercial companies of the state



- Planning, construction, operation, collection and administration of public passenger transport services.
- Execution of urban operations and real estate developments, oriented to the development of the mass transport system, in the terms provided for in Laws 9 of 1989, 388 of 1997, 1682 of 2013 and 1742 of 2014, through any modality of urban action, including the development of urban action units, management units, cooperation between participants, or the other systems provided for in current regulations, using the instruments of financing and land management and in particular, acquiring by voluntary alienation or through the legal mechanisms of judicial or administrative expropriation, the properties that they require for the fulfillment of their object.
- Within the areas of influence of the metro line and its complementary modes, formulate and elaborate planning instruments including urban action units, and coordinate and execute the necessary processes for its formalization and implementation, as well as generation and improvement of public spaces.
- Act as a real estate or land bank according to the scope defined in Law 388 of 1997 and Law 9 of 1989, mainly related to the constitution of public reserves of land, in accordance with the provisions of the instrument, urban action or urban operation to be developed.
- The commercial exploitation of all businesses associated with public passenger transport and advertising spaces.

ROUTE N. Innovation and business centre of Medellín. Its purpose is to contribute to the improvement of the quality of life of the inhabitants of the city through Science, Technology and innovation. Its mission is to articulate the CTi ecosystem to transform Medellín into a knowledge economy, in which, by 2021, innovation will be its main driver. To achieve this, we have set ourselves three strategic priorities: attracting talent, capital and global companies to the city; develop and strengthen the innovative and entrepreneurial business fabric; and generate CTi solutions for city challenges.

Explora Park. Parque of science and technology, aquarium, planetarium, with versatile spaces, memorable scenarios located underwater, at the edge of the universe and in rooms of unconventional experiences, which allow to live the deepest and truest meaning of innovation. But more than a physical work, it is an idea in expansion with vigorous life outside the Park, because for some time its domains extended to other neighborhoods of the city, and even to other municipalities of Antioquia, through workshops, community processes and itinerant experiences such as the Exploramóvil. It is the most important centre of scientific and technological dissemination and promotion in Medellín, and offers the local population and visitors the possibility of stimulating their creativity, experimenting, learning while having fun and building knowledge for the development, well-being and dignity of the city.



Cooperation and Investment Agency of Medellín and the Metropolitan Area -ACI. It is an association of public entities: Mayor's Office of Medellín, EPM, Metropolitan Area of the Aburrá Valley and EMVARIAS. Key actor in the internationalization process for the development of the territory through the construction of strategic international relations, facilitating access to the city and the region of international cooperation resources and the arrival of national and foreign investment.

Metroplús. Entity participating in the management and model of Integrated Transport System specialized in the public service of mass transport land automotive supported by road infrastructure and bus type vehicles, offering an intelligent and sustainable mobility solution that contributes to the improvement of the quality of life of people and the economic, social and environmental development of the benefited territories.

Metroparks. The object is the economic exploitation of the entertainment industry, promoting programs of public and social interest in order to promote healthy recreation and the use of free time for the benefit of the community, through the provision of park services, rental of spaces, production and sale of food or any other lawful activity: as well as support to public and private entities, whether logistical, administrative or otherwise, when for reasons of service they require compliance with their processes and sub-processes necessary for the execution of the purposes or their social objects.

Personería de Medellín (Observatorio de los derechos colectivos y del ambiente). Instrument for the monitoring of environmental problems, animal protection, monitoring of public policies of the Municipality of Medellín, environmental regulations and Municipal Development Plan, according to Law 136 of 1994 and Law 1551 of 2012.

- Ensure compliance with the fundamental right of citizens to a healthy environment, through the monitoring of official actions and the evaluation of indicators in search of sustainable development.
- Track and monitor environmental indicators and develop research.
- Follow-up to the Territorial Planning Plan and the Municipal Development Plan in their lines of habitat, environment and animals.
- Ensure compliance with the rules that protect animals and monitor public policies aimed at their regulation.
- Empower the community with instruments of participation for the defense of the environment.

Youth Secretariat. Dependencia of the central level that will have as responsibility to contribute to the integral human development of the youth, through processes of knowledge, information, training, creation and participation, that recognize the differences, enhance conditions and provide tools that allow them to be agents of change and guarantors of life.

- Implement policies of care and opportunities for youth.



- Mainstream the policies, plans, programs and projects of the Municipal Youth System.
- Coordinate with public, private and community institutions participatory models of youth leadership development.
- Strengthen youth initiatives that develop the intellectual capacity, artistic expression, sports and recreational skills of young people.
- Promote the values of youth coexistence, consolidating a civil ethic necessary to base non-aggression agreements between groups in conflict and guide the processes of reintegration and youth participation.
- Contribute to the guarantee of the rights of the young population of the municipality, in the conservation of life, in the recognition of youth expressions and practices, in labor insertion and identity.
- Generate processes of interaction and exchange of knowledge with youth organizations and the various manifestations and movements of the youth population.

Women's Secretariat. Contribute to equal rights and opportunities between women and men and to the reduction of discriminatory practices that threaten the political, social, economic and cultural development of women in the Municipality of Medellín, through the implementation of the Public Policy for Urban and Rural Women of the city - Agreement 22 of 2003.

- Transverse the policy in the instances and dependencies of the municipality in priority areas and strategic programs previously defined in the strategic plan of the secretariat and in accordance with the Development Plan.
- Generate processes of dialogue and exchange of knowledge with women's organizations and the various expressions of the women's movement.

Instances for the Management of the Renaturalization of Medellín.

The regulatory analysis made it possible to identify 22 management bodies directly or indirectly related to the generation, maintenance, qualification, follow-up and monitoring, and control and authority over the green infrastructure and the ecological structure of the city. However, after the investigations and interviews developed during this phase, it was identified that many of these instances no longer exist, because the agreements that created them were never regulated or were replaced by others.

| Instance | Dependence | Technical Leader |
|---|-------------|--------------------------------------|
| 1. Territorial Council for Environmental Health (integrated IGAM) | Bless you | Henry Haine |
| 2. Technical committee economic use of public space | APP | Daniel Madrigal |
| 3. Intersectoral Advisory Commission on Public Space | APP | Daniel Madrigal |
| 4. POT Strategic Steering Council | DAP | Sebastián Muñoz/Diego Franco |
| 5. Environmental Council of Medellin | Environment | Teresita Vélez Álvarez Diana Agudelo |



| | | |
|--|------------------------|--|
| 6. SIGAM Thematic Committees | | Juan Daniel Cifuentes (Technical Secretary) |
| Integral Management of Water Resources | | Juan Diego Hernandez Castro |
| Strategic Ecosystems | | Yerlyn Valencia Jimenez |
| Wildlife Protection | | Etilvia Vallejo Santana |
| Integral Solid Waste Management | | Maria Camila Ramirez Puerta |
| Integral Management of the Air Resource | | Diana Fernanda Castro Henao |
| Sustainable Production and Consumption | | Sara Restrepo Aristizábal |
| Environmental Quality of the Habitat | | Marcela Noreña Restrepo |
| Environmental education | | Mireya Ossa Villegas |
| Urban Forestry and Landscaping | | Jaime Alberto Gomez |
| Climate change | | Juan Monsalve Cifuentes |
| Toilet and Ornament | | Tomas Tintinago Vasquez |
| 7. Control and surveillance committee to monitor the implementation of the environmental comparendo policy | - | Unidentified |
| 8. Municipal Committee for Disaster Management (and its 8 commissions) | DAGR | Laura Duarte |
| 9. Territorial Planning Council | DAP | Oscar Hernán Betancur (Environmental Tables) |
| 10. Housing Policy Advisory Council | ISVIMED | Juan Camilo Ochoa |
| 11. Municipal Council Rural Development | DAP | Olga Balbin |
| 12. Medellín Environmental Observatory | Personería of Medellín | Carlos Bayer |

Table 6.13: Instances identified with relevance for the formulation of the Renaturalization Plan

| No | Actor | Role | Functions |
|----|-------------------------|-----------|---|
| 1 | Environment | Strategic | Planning, design, execution, maintenance and qualification. |
| 2 | AMVA | Strategic | Planning, follow-up and monitoring, control and authority. |
| 3 | Physical Infrastructure | Operative | Design, execution, maintenance and qualification. |
| 4 | DAP | Strategic | Planning, follow-up and monitoring. |
| 5 | Corantioquia | Strategic | Planning, control and authority. |
| 6 | Universities | Strategic | Follow-up and monitoring, education, awareness and research |
| 7 | Medellin Metro | Operative | Design and execution |
| 8 | Mobility | Operative | Design, execution, maintenance and qualification. |
| 9 | APP | Operative | Design, execution, maintenance and qualification. |



| | | | |
|----|---|-----------|--|
| 10 | INDER | Operative | Design, execution, maintenance and qualification. |
| 11 | Environmental Tables and Social Collectives | Strategic | Follow-up and monitoring, education and awareness-raising |
| 12 | EPM | Operative | Design, execution, maintenance and qualification. |
| 13 | EDU | Operative | Design, execution, maintenance and qualification. |
| 14 | Territorial Management and Control | Operative | Control and authority |
| 15 | DAGR | Strategic | Design, execution, maintenance and qualification. |
| 16 | Miscellaneous Companies | Operative | Design, execution, maintenance and qualification. |
| 17 | Botanical Garden of Medellín | Operative | Design, implementation, maintenance and qualification, follow-up and monitoring, education, awareness-raising and research |
| 18 | Hacienda | Operative | Administrative support |
| 19 | Bless you | Strategic | Planning, follow-up and monitoring, education and awareness-raising |
| 20 | ISVIMED | Operative | Design, execution, maintenance and qualification |
| 21 | Safety and Coexistence | Operative | Control and authority, education and awareness-raising |
| 22 | Comptroller and Personería | Strategic | Follow-up and monitoring, control and authority, education and awareness-raising |
| 23 | FONVALMED | Operative | Design, execution, maintenance and qualification |
| 24 | Camacol | Operative | Follow-up and monitoring, education and awareness-raising |
| 25 | Corregimientos Management | Operative | Design, execution, maintenance and qualification |
| 26 | Government of Antioquia | Operative | Follow-up and monitoring, education and awareness-raising |
| 27 | Police Inspections and Corregidores | Operative | Control and authority, education and awareness-raising |
| 28 | Centre Management | Operative | Design, execution, maintenance and qualification |
| 29 | Cornare | Operative | Control and authority, education and awareness-raising |
| 30 | Economic development | Operative | Execution, maintenance, education, and awareness. |
| 31 | Arví Park Corporation | Operative | Design, execution, maintenance and qualification |
| 32 | Education | Operative | Education, awareness-raising and research |
| 33 | Route N | Operative | Education, awareness-raising and research |
| 34 | Government | Operative | Follow-up and monitoring |
| 35 | City Council | Strategic | Follow-up and monitoring, control and authority |
| 36 | More Forests Corporation | Operative | Design, execution, maintenance and qualification |
| 37 | Citizen Culture | Strategic | Education, awareness-raising and research |
| 38 | Explora Park | Operative | Education, awareness-raising and research |
| 39 | Citizen Participation | Operative | Education, awareness-raising and research |



| | | | |
|----|-----------------------|-----------|--|
| 40 | Municipal Police | Operative | Control and authority |
| 41 | Supplies and Services | Operative | Administrative support |
| 42 | Ecopetrol | Operative | Design, execution, maintenance and qualification |
| 43 | General Secretariat | Operative | Administrative support |

Table 6.14: Proposal of Actors, Roles and Functions for the implementation of the Medellín Renaturalization Plan



Annex 7: Financial analysis

The renaturalization strategy for Medellín, developed in 2019, within the framework of Phase II of the European URBAN GreenUP project, identified the main financing instruments for the generation and maintenance of the green spaces that the city has, which have a regulatory endorsement and some of them have been implemented successfully or unsuccessfully by the administration.

This inventory corresponds to the state of the art from which the financial sustainability strategy for green will be consolidated, which is associated with the ability to generate stable and sufficient financial resources in the long term, to ensure the efficient management of green spaces according to its prioritization criteria. It is built from what is defined by Agreement 48 of 2014 – POT Medellín, Metropolitan Agreement 019 of 2017, Public policy of sustainable construction. Adopted by Metropolitan Agreement 23 of 2015 and other instruments that empower the link with private owners for the generation of resources. These are summarized in Table 6.15 and the definition of each of them is presented in Annex 1.

| # | Type of instrument | Instrument name |
|----|--|---|
| 1 | Defined by Agreement 48 of 2014 – POT Medellín | Urban Obligations/Assignments |
| 2 | | Transfer of construction and development rights |
| 3 | | Sale of construction and development rights |
| 4 | | Contribution in valorization |
| 5 | | Participation in surplus value |
| 6 | | Economic use of public space - AEEP |
| 7 | | Public/private partnerships |
| 8 | | Payment for Environmental Services |
| 9 | | Tax benefits |
| 10 | | Economic Revitalization Area - ARE |
| 11 | | Financing for increase in tax collection -FIRI- |
| 12 | | International cooperation resources |
| 13 | Defined by Metropolitan Agreement 019 of 2017 | Metropolitan Green Fund |
| 14 | | Measures that are part of the Comprehensive Tree Replacement Plan |
| 15 | | Measures complementary to replenishment 1:1 |
| 16 | Defined by the Public Policy of sustainable construction. Adopted by Metropolitan Agreement 23 of 2015 | Soil management tools: |
| 17 | | Fiscal instruments associated with environmental management |
| 18 | | Tax exemptions at the municipal level: |
| 19 | | Soft Credit Lines for the financing of business investments |



| # | Type of instrument | Instrument name |
|----|--------------------|--|
| 20 | Other | Soft lines of credit aimed at consumers |
| 21 | | ESCO Models |
| 22 | | Current income and participatory budgeting |
| 23 | | Sponsorship scheme |
| 24 | | Carbon tax |
| 25 | | Municipal and departmental resources for the protection of water sources |
| 26 | | Transfer of 1% in projects subject to environmental licensing |

Source: Own elaboration based on what is defined by Agreement 48 of 2014, Metropolitan Agreement 019 of 2017 and Metropolitan Agreement 23 of 2015, (2020).

Table 6.15: Inventory of instruments for the financing (generation, maintenance and qualification) of green spaces

6.7.1 Evaluation of instruments

Within the framework of the construction of the financial strategy, 17 meetings were held between May 29 and September 8, 2020, with key actors with roles or interests in the financing instruments previously identified. In these meetings, the impact of the instrument on the generation of green land was evaluated, or on the generation of monetary resources for the maintenance and qualification of green infrastructure. Likewise, administrative or legal complexities were identified that may be limiting their effectiveness and the potential of the schemes to involve private actors in the management of green. Table 6.16 presents the actors involved and the dates of the meetings.³²

| Actor | Topic addressed | Date |
|---|---|---------|
| Botanical garden | Plan Padrino Ecoparque de la Frontera | May 29 |
| Corantioquia | Socialization of the RUPM, Review of the scheme of the Green Windows and its possible articulation to the renaturalization plan | June 24 |
| Ministry of Finance | Collection of INSTRUMENTS from the POT | June 24 |
| Administrative Planning Department - DAP (Instruments Unit) | TEP financing instruments | June 30 |
| Agency for landscape management, heritage and public-private partnerships - APP | Revision of the instrument for the Economic Use of Public Space | July 2 |
| Administrative Department of Environmental Management Cali - DAGMA Cali | Referencing program of adoption of green areas Cali | July 6 |

³² The minutes and recordings of each of these meetings are part of the contractual evidence and rest on supervision.



| Actor | Topic addressed | Date |
|---|---|-------------|
| Administrative Planning Department - DAP | Specific destinations of the TEP instruments | July 8 |
| Administrative Planning Department - DAP | Revision of the sustainable construction manual | July 13 |
| Administrative Planning Department - DAP | Payment for environmental services-PSA | July 16 |
| Administrative Department of Planning - DAP. Agency for landscape management, heritage and public-private partnerships - APP | Economic use of public space | July 21 |
| Administrative Department of Environmental Management Cali - DAGMA Cali | Continuation referencing program of adoption of green areas Cali | July 23 |
| Metropolitan area of the Aburrá Valley - AMVA | Metropolitan Green Fund and Additional Compensation Measures | July 29 |
| Ministry of the Environment - SMA | Presentation of the progress of the project to the lawyers of the SMA | August 4 |
| DAP | Presentation of project progress to the DAP planning unit | August 14 |
| UPB, Camacol and AMVA | Review of financing instruments for the Public Policy on Sustainable Construction | September 3 |
| Budget | Presentation of the Financial Strategy, feedback on financing instruments for the green | September 7 |
| Camacol | Review of financing instruments for the Public Policy on Sustainable Construction | September 8 |

Source: Own elaboration, (2020).

Table 6.16: Meetings held for the financial strategy

Evaluation of the instruments defined by Agreement 48 of 2014 – POT Medellín

The evaluation of the financing instruments defined by the TEP was carried out taking into account their destination to the Subsystem of public space for recreation and meeting (both for the generation of public and collective systems, as well as for their qualification and sustainability); to the extent that the objectives of the RUPM are articulated to the actions of this subsystem aimed at increasing the rate of effective public space and generating green land and connectivity as a mechanism aimed at expanding the supply of urban green infrastructure. As a result of the meetings held with the DAP, it is the need to:

The **Urban Obligations** are considered relevant to the Renaturalization Plan of Medellín the areas of public cession, destined to land for effective public space of recreation and meeting. However, the areas of land destined for the construction of basic community facilities could represent a potential insofar as it is feasible to implement NBS in them. This is the instrument that has the greatest potential to be incorporated into the RUPM, since it is regulated (Agreement 48 of 2014, Decree 2167 of 2014, Decree 621 of 2017), is subject to collection



(compensated in money) and has a specific destination for green. Therefore, it is important to generate within the RUPM a specific project that aims at this area, or consider it as a primary source for the generation of green space.

According to information reported by the Administrative Department of Planning, the resources of urban obligations have been invested in the generation of green public space from the following initiatives:

Acquisition of private properties that are part of the Cerro de las Tres Cruces: 1,082,110 m². Of this total area, 8 properties have been purchased (438,433m²) through voluntary sale and pending the purchase of 5 properties that will undergo an administrative expropriation process.

Provision of land for effective public space, which may or may not have green areas in Ciudadela Universitaria: 10.039m².

Purchase of land for effective public space, which may or may not have green areas in Cable Picacho: 17,254m².

Before Agreement 48 of 2014, land for green public space was acquired with urban planning obligations, such as: Parque la frontera (Poblado), Parque de San Pablo (Pilarica), Finca Montecarlo Comuna 3 and public space adjacent to the library of San Cristóbal, among others.

However, based on the results of the meetings held within the framework of the RUPM's financial strategy, operational limitations are evident for the allocation of resources collected by urban obligations. This aspect is reflected in the fact that the accumulated resources of previous management plans (Agreement 62 and Agreement 46) and close to 117 billion pesos, were allocated by emergency to the attention of the COVID-19 pandemic, in accordance with the provisions of Decree 0444 of 2020. The remaining 12 billion will be allocated to the direction for the sale of construction and development rights for heritage and the achievement of new public spaces for urban renewal. While 1,900 million for specific destinations. The delay in the execution of resources, according to the results of the meetings held, is due to the lack of intervention and management projects of the units in charge (especially SMA and SIF), given that many of the projects, although they entered the instance of the Strategic Steering Council of the POT (CDE), did not meet the criteria to be generators of public space, therefore, the destination is limited.

In this regard, it is important to note that the Strategic Steering Council of the POT (CDE) is the body created for strategic decision-making that guarantees the development of the strategic framework of the POT. Its objective is the prioritization of projects for the realization of the TEP occupancy model. It is made up of the Ministries of Finance, SIF, DAP, Services and Supplies, Management and territorial control. The projects evaluated by the CDE must be part of the MIP or correspond to the goals of Agreement 048 (be registered in the POT project bank). It has a technical committee (this is the first instance) that evaluates whether the project can be enhanced with the resources associated with urban obligations, and if the project has the capacity to be sustainable (if the dependencies that manage the project have resources for its support), for which it must be supported with licenses or permits and maintenance plans, that allow the evaluation of sustainability over time. If the project passes the instance of the technical committee continues with the instance of the CDE.



With regard to the **Venta and Transfer of construction and development rights**, regulated by Decree 1812 of 2016, it constitutes a right that specifies the possibility of developing a property with additional use, in exchange for a monetary consideration that the individual must pay for the right to use them in areas receiving construction and development rights. It becomes an instrument to be promoted within the framework of the RUPM since it is an instrument with a specific destination for the subsystem of public space for recreation and encounter, and integrates the areas of the ecological structure, as well as the areas of mitigable threat and risk, which can be converted into public space; additionally, it is associated with the mobility subsystem.

It is an instrument that allows the municipality to grow in effective public space and continue in its process of consolidation of the EEP. It is developed from two modalities the transfer for patrimonial assets and the environmental transfer. Although the environmental transfer does not represent monetary resources for the municipality, the possibility of generating land for green PE. This can be articulated to the financial strategy of the RUPM.

The **Contribution in valuation** as a tax charged to the owners and possessors of real estate, due to the economic benefit obtained with the execution of works of public interest, intended exclusively to meet the expenses demanded by said works. although it corresponds to an instrument that contributes more priority to the mobility subsystem, it has a specific destination to the subsystem of Public space for recreation and encounter and could generate resources for green in the area of interference of the project of generation of public space that causes the benefit.

Similarly, the resources managed from the Participation in the **surplus value** could be considered within the framework of the RUPM to finance future interventions associated with NBS, in the works that cause the benefit. This corresponds to the instrument that allows the Municipal Administration to participate in the increase in the value of the land caused by the urban actions or public works carried out by it, without any intervention of the particular owner of the property, allowing to recover part of said increase in land prices and redistribute it in the territory, through the reinvestment of these resources in urban development.

The instrument associated with the **payment for environmental services PES water**, regulated by Decree 1910 of 2016, was evaluated within the framework of the RUP. It corresponds to the economic incentive paid for 1 year, according to the area in conservation or restoration owned by the owner of a property according to the eligibility map (Those properties that are under the use of the Protective Forest land in the EEP and in the UPR la Puerta and Doña María will be eligible for PSA). The scheme is currently operated by the SMA in coordination with the MAS BOSQUES Corporation, from the resources corresponding to 1% of the municipal current income for supply basins: maintenance, reforestation, studies and designs.

Although it constitutes an instrument with specific destination both to the Subsystem of public space of recreation, as well as to the areas of the ecological structure and the areas of threat and mitigable risk, so it develops the possibility of increasing the public space, there is no potential to link with the implementation of NBS, because it is subject to the properties inside the eligibility map.



From the **Financing for increase in tax collection -FIRI-** established in article 536 of Agreement 048 of 2014, the Municipal Administration will make viable and facilitate the processes of Urban Renewal and Integral Improvement, through the financing of projects of public space, equipment, mobility and housing of social interest. This instrument may be directed to projects for the expansion and / or replacement of the primary networks of domestic public services in the Strategic Intervention Areas of the River Corridor and the Urban - Rural Edge, as defined by the entity providing public services and the Municipal Administration, in the Infrastructure Plan to be formulated.

It corresponds to a mechanism in the process of regulation that will allow the future financing of a percentage of the urban renewal processes mentioned above. At this time it is not possible to incorporate it into the objectives of the RUPM.

The **Areas of Economic Revitalization – ARE**, established in article 543 for their part, correspond to a partnership between public entities and private agents, in which establishments located in a defined area, assume an increase in their taxes as a result of agreed improvements, which involve assets of public space, in exchange for maintenance, improvement or recovery, restitution, control and surveillance over them.

From this instrument, the private sector revitalizes its area of influence, but from interventions on the public space, not on the green component. It is in the process of being regulated. It has involved resources from the economic use of public space and voluntary contributions from owners and merchants who, at will, decide with these contributions to qualify the public space of a sector, with a view to generating greater value of their real estate and / or businesses. It corresponds to an instrument for investment in equipment rather than green space, so it is not considered a priority within the framework of the Renaturalization Plan. To date, the municipality has begun its application on the boulevard of the 70, but the results of its implementation have not been evaluated.

The **tax benefits**, on the other hand, correspond to incentives in favor of property owners, for contributing to the realization of the POT occupation model, with a view to alleviating urban burdens inherent in the process. Agreement 048 establishes that tax benefits may be implemented in an alternative or complementary manner to the allocation of transferable construction and development rights or other compensation mechanisms; for its part, the tax statute of Medellín (Agreement 66 of 2017), determines in its Book II, the regulation for the benefits associated among others, to the exemption on property tax, industry and commerce tax, urban delineation, as well as the benefits to sustainable construction. The latter will be addressed in greater detail in the following sections.

According to the Medium-Term Fiscal Framework Report of the Municipality of Medellín (2020-2029); in 2018, 13,756 people benefited from the exemptions defined in the tax statute (property tax, industry and commerce, public lighting, public spectacles), of which 1,247 corresponded to legal persons and 12,509 to natural persons. In 2018, the value of the tax benefits (exemptions) granted to taxpayers of the Municipality of Medellín reached \$ 121,843 million pesos, of which 83.7% were exemptions in the property tax.

Finally, **international cooperation resources**, although they are part of the financing mechanisms, have been limitedly accessible by the SMA. They are considered as potential



resources for the implementation of NBS, within the framework of the RUPM, but greater management is required by the competent areas to access this type of resources.

However, with regard to the instruments for the qualification and sustainability of public and collective systems, there is the **Economic Use of Public Space (AEEP)**, defined by article 540 of the POT, regulated by agreement 050 of 2015 and decrees 2109 of 2015, 2148 of 2015, 522 of 2018 and 2229 of 2019.

The AEEP corresponds to actions aimed at guaranteeing the sustainability and collective enjoyment of public space, which can be developed by natural or legal persons, through the signing of contracts for administration, maintenance and / or economic use. This, in any of its 7 categories, becomes an instrument conducive to the maintenance and qualification of public space, not only for its specific destination, but for the potential represented by the PPP and the resources of compensation of economic use, for the future maintenance of green areas, as well as for the possibility of involving private third parties in the management and qualification of green.

The following correspond to the categories of the AEEP defined by Decree 2229 of 2019:

Category: Urban furnishing and infrastructure of public services, for economic purposes on a temporary basis.

Category: Economic activity on and under roads and public spaces of recreation and meeting in Temporary Form as:

- Subcategory: Mobile Economic Units – EMU.
- Subcategory: Valet parking.
- Subcategory: Shared micromobility on the road.
- Subcategory: Transport logistics centres, bus depots and public parking lots subject to AEEP.

Category: Tables and Chairs in Temporary and Transitory Forms.

Category: Advertisements in Temporary and Transitory Forms.

Category: Economic use of air and underground links in Temporary and transitory.

Category: Occasional events for economic purposes in Transitory Form.

Category: Non-permanent amusement parks in Transitory Form.

As regards the types of contracts for the AEEP, Article 540 of Agreement 048 of 2014 provides: contract for the maintenance of the JV (compensation in kind); contract for the administration of the JV (compensation in kind) and contract for the economic use of the JV (compensation in kind and/or in money). While article 13 of Decree 522 of 2018 regulates the administration contract with economic use of public space (compensation in kind and / or in money). The latter could be enhanced within the framework of the RUPM to the extent that a third party can carry out AEEP from the category of urban furnishing, advertisements, tables and chairs, occasional events for economic purposes, micromobility, etc.; and in compensation the third implements NBS, maintains the public space and the green area (compensation in kind).

Finally, it is important to consider that the implementation of the instruments associated with the POT based on the provisions of the Management System for Territorial Equity, is addressed through the mechanism of Distribution Areas, through representation by areas of intervention,



this allows to determine where the resources obtained by concept of the payment of urban obligations in money or other financing instruments will be effective.

The collection for the year 2019 corresponded to a total of \$91,907 million pesos. This indicates that the collection of the financing instruments of the POT is about 1% of the income of the municipality. The instruments that generated the highest collection correspond to the contribution in valorization (65% of the resources collected), Urban assignments (31%), the remaining 4% is related to collections for Economic use of public space, payment for water environmental services, participation in the surplus value and sale of construction and development rights.

The DAP is in the process of building the instrumental system of the financing subsystem. The instruments associated with the additional use in expansion polygons, other PES, for example, carbon, are pending regulation and definition; transfer of environmental construction rights, and financing for increased tax collection-FIRI.

Evaluation of the instruments defined by Metropolitan Agreement 019 of 2017

Metropolitan Agreement 019 of 2017 establishes the formation of the Metropolitan Green Fund for the generation and administration of new green public space, and for the planting and maintenance of urban trees. It enables different tools for the compensation of green public space from a minimum compensation and additional measures. It is regulated from Resolutions Resolution 2247 of 2018 (Adopts the model that establishes the unit of ecological value - UVE, for urban trees). Resolution 2248 of 2018 (The Metropolitan Green Fund is formed, establishes the guidelines for its operation, direction and administration). Resolution 3677 of 2018 (by means of which additional conditions are established for the procedures of forest use advanced before the AMVA). Metropolitan Agreement 33 of 2018 (adopts the procedure of delivery, destination, and administration, of new green public spaces generated on the occasion of the measures established in Agreement 019 of 2017).

The green fund was constituted as an instrument of promotion and encouragement to conserve, restore, encourage, increase and sustain the urban green public space, its financing was raised from resources from forest use procedures, fines collected in environmental sanctioning processes. The resources of the fund are specifically allocated for the acquisition and administration of new green spaces, planting and maintenance of trees and other additional measures; likewise, the properties that can be acquired must integrate strategic ecosystems, areas of environmental importance, urban ecological networks, and the system of green public space, among others.

At the time of preparation of this report and according to a meeting held with the AMVA, the resources raised by the fund correspond to a total of \$2,655,471,000 derived from forest use procedures (112 procedures evaluated from the agreement- August 2018), visits, fines and sanctions. However, these resources do not allow the purchase of land for green, so the guideline of the AMVA is to consolidate a thick fund, which allows the call to the municipalities for the purchase of land.

The Green Fund is in the operational approach stage, for these 6 stages have been proposed that include: call (elaboration of terms of reference and socialization), reception of proposals (municipalities submit projects or bank of properties), prioritization (parameters for



acquisition, intervention and administration), evaluation (operational committee reviews, inspects properties, and issues concept), and execution (preparation of agreements, fiduciary orders, tenders, contracting). To this end, the AMVA is scaling up an operational structure that includes a steering committee (composed of director, general secretary and deputy directors), administrative committee (composed of leaders heads of office and programs) and operational committee (made up of delegates from the units of environmental management control and surveillance, accounting, budget, planning and legal advisory offices).

Although there is potential for synergies with the RUPM, a phase of definition and subsequent scaling of the scheme within the AMVA should be expected, to concretize articulation.

Additionally, the AMVA is in definition of an urban PES scheme, based on ecosystem services related to carbon sequestration and biodiversity. The stage of structuring the incentive and estimating the value is in the stage, which will constitute a basis for determining required resources and financing. Likewise, properties with the potential to generate ecosystem services, their legal quality and the possibility of crossing with the property tax exemption are being reviewed.

With regard to the additional compensation measures defined by Agreement 019 of 2017 and Resolution 2247 of 2018, the RUPM becomes an opportunity to review and expand such compensatory proposals; so that NBS can be incorporated as possible compensation solutions. Associated with paragraph 4 of article 4 of Agreement 019 "The execution of complementary activities such as maintenance of juvenile trees, design and implementation of wildlife passages, among others, for a value equivalent to the result of the application of the model adopted in this Agreement, which remains of the planting in replacement". In this sense, the compensation could eventually include wildlife passages, green walls and sustainable drainage systems, achieving synergies with the NBS.

However, based on the information reported by the AMVA regarding the Green Fund, it is not possible to make a more detailed analysis of how the financial strategy could be articulated within the framework of the RUPM, around the common objective of increasing the green areas of the city.

Evaluation of the instruments defined by the Public Policy on Sustainable Construction

The Metropolitan Public Policy on Sustainable Construction adopted by Metropolitan Agreement 23 of 2015 urged municipalities to consolidate a municipal policy of sustainable construction. The municipality of Medellín has been advancing in this challenge, based on the formulation of the Sustainable Construction Manual for Medellín, in charge of the Subdirectorate of Territorial and Strategic Planning of the City, of the Administrative Department of Planning. This manual generates an environmental look through low-carbon construction. It aims to minimize the negative impacts of construction by adding principles, criteria, measures and specific application practices for efficient construction. It develops optional and mandatory measures related to: environment and environment, efficient consumption of energy and water, specific comfort indices of sustainable construction, sustainable materials and solid waste management. It also defines 34 subvariables to measure



the degree of sustainability of each project and generates a proposal for financial and fiscal incentives for its promotion.

With regard to financial incentives for sustainable construction, they are regulated by Municipal Tax Statute (Agreement 066 of 2017), in its chapter IX, Article 315, There are related the benefits (incentives) for sustainable construction, from percentage deductions on the urban delineation tax and the unified property tax.

In this sense, it is available for those constructions that exceed the levels of mandatory savings of water and energy in development of the provisions of Resolution 549 of 2015 of the Ministry of Housing, City and Territory, and that conform to the criteria of the Sustainable Construction Evaluation Matrix of the Sustainable Construction Manual. These incentives consist of the deduction of 10% on both taxes, for strata 1 and 2; 8% for stratum 3; 6% for stratum 4; 4% for stratum 5 and 2% for stratum 6. Incentives will be granted for 10 years, depending on the degree of compliance with the conditions or categories of sustainable construction that are defined in the Sustainable Construction Evaluation Matrix of the Sustainable Construction Manual.

However, it is important to note that in October 2019 and in response to metropolitan agreement 05 of 2009 in which sustainable construction is declared as a metropolitan fact, CONPES 3919 associated with the National Policy on sustainable buildings, and Metropolitan Agreement 23 of 2015; the Alliance for Sustainable Construction is created, as an institutional framework for cooperation of knowledge transfer and training for builders. So that knowledge and research capacity is closer to the builder, through the cooperation of AMVA, CAMACOL and the Pontifical Bolivarian University. In this order of ideas, this Alliance is concretized as an academic instrument, rather than financing for sustainable construction.

The sustainable construction policy establishes as financing instruments for sustainable construction initiatives those associated with:

- Soil management tools

Fiscal instruments associated with environmental management

Tax exemptions at the municipal level

Soft Credit Lines for the financing of business investments

Soft lines of credit aimed at consumers

ESCO Models

The financial instruments currently implemented for the promotion of sustainable construction are mainly associated with land management instruments, environmental compensation and tax exemptions at the municipal level (property tax, urban delineation tax, alignment tax). The ESCO models and the soft credit lines are active with the banks (Bancolombia and Davivienda), associated with construction based on sustainable construction criteria, however, it is not feasible to involve the implementation of NBS in its operation.

As a result of the meetings held within the framework of the financial strategy for the RUPM, the following considerations are presented, presented by Camacol:



It should be tended by the habilitation of banks of areas for purchase of green floor (bag where the private company finds areas of compensation) from said inventory, the builder can propose areas of compensation to the AMVA according to availability. Builders have limitations because they can't find property or compensation opportunities. It is important to articulate the results of the RUPM around the consolidation of an offer of lots of interest for public space and for the generation of new sites for planting, given that the current possibilities for the application are limited in practice, due to the lack of land.

There must be synchrony between the provisions of the municipality and the regulations of the AMVA, so as to guarantee legal certainty for builders. In practice, there are blockages in institutions that limit the entry of resources, as well as difficulties in the implementation of initiatives due to lack of personnel to accompany the processes. According to Camacol there are gaps in the implementation of Metropolitan Agreement 019 (green fund) many builders prefer to pay in kind than to contribute the resources, since the resources enter a common bag and many times the destinations are not executed as planned. Likewise, it is necessary to evaluate the operability of the instruments until the moment of delivery of works, for example, for the issue of sustainable drainage, it is not clear who receives them and who monitors them and how their sustainability is ensured.

- Consider carbon neutral offsetting, this would be an instrument to enhance. Companies calculate the carbon footprint, but they do not find properties to compensate, companies have resources to make compensation, but not properties, the plan can eventually generate zones or compensation area.

A source to be promoted is sponsorship with commercial stimulus. As well as involving tax exemptions declared by the tax statute (income deduction), which promote intervention in the green. You can involve a contest for the improvement of green areas or the design and implementation of green infrastructure, (public landscape contest), where companies make design proposals and the compensation is in digital marketing.

Other instruments

Sponsorship scheme evaluation/ Sponsor Plan

Within the framework of the "Development Plan 2016 – 2019 Medellín Cuenta con Vos", a sponsorship scheme called "Plan Padrino de zonas verdes" was formulated and implemented, from which it was intended to promote participation through an agreement of wills between social and private organizations and the municipal administration to generate awareness of environmental care and promotes that the citizen can maintain and protect some of the public green areas which are in charge of the municipality of Medellín, exalting the importance of the conservation of renewable natural resources.

This participation for maintenance was planned to be carried out through cleaning, planting, spraying, pruning actions in places in the city where there is a presence of the green component which is part of the green infrastructure: ravines, road corridors, roundabouts and parks; and the generation of new green areas through actions of design and construction of Ecoparks and urban and rural ecological corridors, under parameters and supervision of the SMA, and according to the specific conditions of each section to be sponsored.



As the scheme was formulated, the Ministry of the Environment of Medellín, through its Secretary of the Environment, was in charge of administering this project, and in agreement with the Botanical Garden of Medellín, offer private companies and other private sponsors the possibility of sponsoring the city's broken-up Ecoparks, directing the coordination of volunteers in processes of community environmental education and assistance for the beautification of the landscape and cleaning projects.

Private or mixed companies, non-governmental organizations NGOs and / or natural persons with the capacity to contribute to the protection of the environment could participate in the scheme, benefiting the community surrounding the Ecoparks, while obtaining tax advantages associated with the donation of resources to the Joaquín Antonio Uribe Botanical Garden Foundation for the care of the Ecoparks of Quebrada.

The actions proposed to develop the Plan Padrino strategy of Ecoparques de Quebrada included the maintenance and/or environmental and landscape improvement of the public spaces associated with the ravines of the city of Medellín. In this strategy and with the accompaniment of the SMA and the Botanical Garden, the business and academic community of the city could carry out:

- Environmental days, based on activities to encourage the environmental spirit through maintenance days of public spaces, which may include, garden planting, maintenance of equipment, urban furniture and general cleaning.
- Planting days, after approval by the Ministry of the Environment, of native species suitable for improving the floral composition and landscape of the city.
- Recovery of children's games, which consists of carrying out maintenance and installation of children's games in public spaces that present this need.

The benefits for the private sector of adopting a green zone included:

- Tax benefits established by the Law from the investment made by companies as a donation to the Botanical Garden.
- Permission to install a fence that allows the sponsor to advertise about their company, brand or institution within the Ecopark.
- Press releases regarding the sponsor, in order to make free press in front of the media.
- Carry out promotion of the sponsor company within the events of the Municipality of Medellín.
- Advertising in public spaces with the presence of the sponsor's brand as an environmental participant.

The strategy managed to characterize in detail 10 of the 34 ravine Ecoparks in the city, which included topographic survey, forest inventory, and maintenance costs. The group in charge of the Strategy of Plan Padrino was made up of officials from the Secretary of the Environment of the Municipality of Medellín (Undersecretary of Natural Resources) and the Botanical Garden of Medellín.

The municipality managed to implement a first pilot of the Padrino Plan scheme for the Bosques de la Frontera Ecopark, which consisted of the maintenance of 293 tree individuals,



maintenance of gardens, environmental education and socialization activities, for a period of 3 months. The way of operating the contract was through a partial cession of the public space, where a third party (ARGOS) delivered the monetary resource to the Botanical Garden (with a specific destination of use), which executed said donation in a public space (Ecoparque), from a contractual figure of commodity with the municipality of Medellín.

As a result of the implementation of the pilot and within the framework of the meetings held with the Botanical Garden as promoter of the scheme, the following considerations are taken:

- The sponsorship scheme is a figure that must be enhanced for the maintenance of public spaces. In this regard, it is important to characterize the green areas that are considered to be the object of donation.
- A limitation in the implementation is recognized, associated with the absence of a fund, account or specific figure where resources can be received for sponsorships, so that the third party can deliver the resources for the maintenance of the green zone and these are managed through the Ministry of Finance.
- Longer intervention periods are required and in prioritized areas that are part of the main ecological structure, which at this time are not being intervened by resource constraints. Thus, consider in the scheme adaptations (qualification), planting, establishment of trees and gardens.
- Finally, in the evaluation of the scheme, which was carried out with the officials of the Botanical Garden, emphasis was placed on the process of outsourcing the management of green areas; in this regard, it was pointed out that the management should be carried out by a specialized third party, that is, limit the scheme so that the maintenance or management of the green area is not executed by the third party donor without the expertise required for it.

However, within the framework of the financial strategy for the RUPM, a referencing of the green zone adoption scheme carried out by the Administrative Department of Environmental Management -DAGMA- in Cali was developed. It showed that the municipality of Santiago de Cali has consolidated a sponsorship program for 16 years. It currently has 126 adopted zones, with 129 adopting companies, generating resources of around 180 million per month and 2,800 million per year. The objective of the program is to improve the spaces and green areas of the city. Cali has 12.8 million m² susceptible to adoption by the program, which include parks, ecoparks, wetlands (included if the wetland management plan authorizes it) and road separators, which are offered to private companies, so the program aims to attract the attention of private companies, to improve and sustain these spaces over time

The referencing showed that it is an instrument that allows the generation of expeditious resources for the maintenance of green. It is a scheme based on an agreement of wills or social responsibility, developed in a period between 1 to 5 years, in which 4 maintenances per year of the green zone are guaranteed and where environmental governance plays a fundamental role, to the extent that it allows citizens to be empowered by these spaces. It is executed in the company of the environmental police, they consider the street dweller and generate the appropriation of the citizenship. Where the private receives the following benefits:

- Tax (Decree 3172 of 2003)
- Marketing in public spaces (digital marketing): The project has a TV program where the adoption program is highlighted and marketing is done for the sponsor. Prizes are



generated for contributors, the most embellished area is awarded, the company is decorated by the mayor.

- Implementation of Environmental Social Responsibility (RSA) in companies: Environmental Certification for Corporate Social Responsibility (CSR)
- Recognition at the municipal and government level
- Institutional support in environmental issues for the employees of the organization (planting and maintenance days, space recovery days)

The environmental authority (DAGMA) supports from beginning to end the development of this proposal and for this it contemplates three activities:

- Preliminary activities: includes land enlistment, forest inventory. DAGMA budgets these activities and budgets a monthly schedule.
- Beautification activities: analysis of the environment, type of plants. DAGMA suggests the proposal in accordance with the proposed action plan
- Sustainability activities: the sponsor develops the activities month by month, by hiring an operator, endorsed by the DAGMA.

Other schema considerations:

- The donor company executes the maintenance (with the third operator it selects) under the mentorship of the DAGMA. If the third party cannot qualify the space, the municipal nursery provides the resource and the sponsor provides the maintenance of the area. The instrument works with the monetary resources of the private sector. This private wants to show itself and comply with environmental social responsibility.
- It operates as an agreement of wills or social responsibility; not as an administration contract. There are no penalties for the third donor and this is not legally obligate, only empowered to execute the intervention. The minimum time of the agreement is 1 year, where 4 maintenances per year of the green zone are guaranteed. If the company cannot continue with the agreement, it is given one month for the delivery of the green space, the visual outdoor advertising is removed and the space is delivered to the DAGMA.
- The annual goal of the program is 50,000 m² adopted through 12 agreements (1 per month). The cost of maintenance is \$400/m². The scheme has 610,000 m² which represents an investment of the companies of \$ 190,000,000 per month.
- The work team linked to the monitoring of the scheme is composed of 6 people, who make the evaluations of the areas: two (2) technicians, one (1) topographic engineer, one (1) Architect, one (1) Administrative Assistant, one (1) Coordinator. The technicians carry out monthly follow-up visits, which are distributed by communes.
- The program contemplates by the DAGMA the planimetric survey of the zones; eye visits, to know the present state and propose the future state of the area. An evaluation of the vegetal, arboreal and ornamental layer is made, landscape designs are made. It also includes training and environmental talks. The DAGMA donates seedlings to improve urban trees.
- The minimum duration of the scheme is 1 year, maximum of 5 years. (they verify the sponsorships in 4 communes of the city), the technicians follow up and pass a monthly report. However, the company makes a monthly report of activities with evidence. The monitoring of the program is done by the operator hired by the company, he exercises the maintenance tasks of the area (pruning of dead and dry branches, replanting, maintenance of the pruning vegetal layer, cleaning, pest control, cleaning, among others), so the maintenance costs are assumed by the private company. The adopted areas are usually close to the environments of the companies they sponsor. The program is articulated with the spatial unit of public services of the city, in this sense,



the sponsored areas are excluded from the cleaning fee, this is assumed by the sponsor is not charged via fee.

- It is important to recognize that since the DAGMA that is the promoter of the scheme is the same metropolitan environmental authority, it generates additional synergies for the adoption process, around issues of air quality, solid waste, among others.
- The documents related to the scheme correspond to:
 - Agreement of wills (without legal penalties)
 - Follow-up report
 - Sponsorship intention format (companies request the areas to be sponsored). It is a process of permanent accompaniment between the DAGMA and the company.
 - Vayas design format: The vaya is designed by the DAGMA, has a unique design and has a blank space for the company to put its logo.
 - Advertising can be published on the company page
 - Format of work schedule (monthly diligence).

Evaluation of the Medium-Term Fiscal Framework

The Medium-Term Fiscal Framework -MFMP- is a financial planning tool of the public sector, established by Law 819 of 2003, which, based on the estimates of the current year and in the context of internal and external conditions, aims to build a feasible path with a ten-year perspective, for fiscal decision-making.

Within the framework of the financial strategy of the RUMP, the MFMP was reviewed in partnership with the Municipal Budget unit, with the aim of determining current items without specific destination that could be promoted for investment in urban green. As well as reviewing the feasibility of allocating a small percentage of the Industry and Commerce Tax for green, from compensation for economic activities related to parking lots, bus terminals, ZER, public works (compensation taxes).

However, the municipal current resources are committed in future terms for the financing of the 1.1 billion pesos, which the municipality must contribute to the Light Rail project of the 80, which is why the evaluation of the items of the current budget was not pertinent.



Annex 8 - 30 GREEN CORRIDORS

PROJECT: 30 GREEN CORRIDORS

5. Who have been the main participants involved in this work? Can you describe your roles?

The Mayor's Office of Medellín has been intervening 30 Green Corridors: eighteen (18) associated with mobility intervened by the Secretariat of Physical Infrastructure and twelve (12) associated with withdrawals of streams intervened by the Ministry of the Environment.

The corridors corresponding to the Secretariat of Physical Infrastructure:

Secretary of Physical Infrastructure: *Paula Andrea Palalacio Salazar*

Undersecretary of Planning: *Silvia Elena Gómez García*

Undersecretary of Construction and Maintenance: *Andrés Felipe Uribe Zapata*

University Professional (Civil Engineer), project supervisor: *Carolina Pabón Muñoz*

University Professional (Environmental Engineer), project supervisor: *Lina María Vanegas González*

Team of the Strategic Urban Projects Management, made up of:

Director: Doctor Architect Engineer *Alejandro Restrepo Montoya*.

Coordinator: *Carolina Londoño*.

Professional: Bioclimatic *Alexander González*.

Professional: Forest Engineer *Mauricio Jaramillo Vásquez*.

Professional: Landscape Architect *Nicolás Hermelin Bravo*.

Professional: Architect Designer *Edgar Mazo Zapata*.

Professional: Architect Designer *Sebastián Mejía Alvarez*.

Professional Architect: *Sebastián Ramirez, Camila Katich, Diana González, Lina Upegui Lopera*.

The corridors corresponding to the Ministry of environment are in charge of the Undersecretariat of Natural Resources - Ecological Structure Unit who have participated during the formulation, initiation and development. This team is made up of:

Secretary of the Environment: *Sergio Andrés Orozco Escobar*

Undersecretary of Natural Resources: *Javier Eduardo Posada Muñoz*

Program Leader: *Jaime Alberto Gómez Cuervo*.

Professional: Landscape Architect *Marcela Noreña Restrepo*.

Professional: Forestry Engineer *Ana María Villa Grajales*.

Professional: Forestry Engineer *Fabio Saldarriaga*

Professional: Architect *David Andrés Mejía Gómez*.

The professional supervisors, officials assigned to the Ministry of the Environment are the ones who monitor the contractor who develops the project, and it is the latter, the one in charge of hiring the professional staff and labor for its fulfillment. Within the project were hired by the operator Botanical Garden seven (7) professional Forest engineers four (4) Technicians and 18 gardeners.



6. **Can you give examples of the types of trees and vegetation that have been planted and the reasons why they were selected? He mentioned 96,000 "minor species" planted on Avenida Oriental. What kind of species are they?**

Species have been planted that generate shelter, serve as perch, rest and food for fauna such as guava (*Psidium guajava*), Guamo (*Inga herreriae*), ariza (*Brownea ariza*), among others. Species that help reduce the temperature by their large porte such as Green Ceiba (*Pseudobombax septenatum*), Ebano (*Caesalpinia ebony*), Chiminango (*Pithecellobium dulce*), Caracolí (*Anacardium excelsum*).

The improvement of the landscape with the multistratification, naturalization and enrichment of the landscape, in which each individual makes his contribution. In addition to the selection criteria, the supply of plant material existing in the nurseries is also taken into account, which are species that belong to the American tropics and that have successful experiences of adaptability to the ecological conditions of Medellín, which is located in the Premontane Humid Forests life zone (Holdrige Life Zone Classification System). Additionally, it was taken into account that the material to be acquired outside nurseries with certification of the quality of plant material.

Table 6.1 presents the tree species that were planted in the Avenida Oriental corridor and their size or level of growth (high, medium and low).

In the corridor of Avenida Oriental, 96,000 plants (individuals) corresponding to "minor species" that are shrubs were planted (see Table 6.2)

7. **What percentage of the entire "30 Green Corridors" project is complete? When is its conclusion planned? He mentioned that 100% of the central corridor of Avenida Oriental is complete, that there has been 15% progress in the lateral zones, and that the completion is planned for May 2019. Are they on track to meet this deadline?**

Table 6.3 and Table 6.4 presents the progress of each of the corridors, according to the programming of the project these must be completed in their entirety by November 2019.

8. **Set the approximate-planted total area in square meters or hectares. He mentioned that Avenida Oriental has received 2.3 km of vegetation. What is the total length in combination of all runners?**

Table 6.6 and Table 6.6 shows the approximate area of each of the corridors.

12. **What percentage of Medellín is green space? To what extent has it increased as a result of the project?**

At the moment the Municipality of Medellín does not have the updated inventory of green areas for its entire urban area, however, according to the Master Plan of Green Public Spaces made by the Metropolitan Area of the Aburra Valley in 2006, it is established that for the urban area of the Municipality of Medellín there is 18.9% of green public space. However, the Ministry of the Environment carried out in 2016 the "Pilot Project for the Ecological Connectivity of the Urban Green Corridors of the Municipality of Medellín - Phase 1", in which the analysis and study was carried out for 25% of the entire urban area of Medellín, corresponding to 2,955ha, finding as effective



green areas a total of 48,351 polygons of green areas, totaling 828.68 ha, which corresponds to 27% of the total study area.

Given that with the Green Corridors associated with streams the interventions have corresponded to the planting of trees, shrubs and palms, in this type of corridors there has been no increase in green space, but an enrichment and improvement of the conditions of the green areas has been carried out. The increase in green spaces has been generated with the green corridors associated with the roads, with which it has been possible to convert 20,808 m² from hard floor to soft floor (see Table 6.7).

While the 20,808 m² that have become the city centre is a low figure, it is really significant, considering that the total green areas this area has around 24,000 m² mainly located in the parks inside the centre of Medellín.

This project is a commitment to the greening of the city, improving the spaces that allow to start with a Public Policy to continue over time and increase the index of green space for the city and positively impact the environment.

13. How is the impact of green corridors currently being monitored?

So far, weekly or biweekly visits are made to the corridors to observe the growth, performance and stability of the plantings carried out; as well as the social acceptance of them. As this project is so recent, studies have not yet been established to monitor the impact, however, in the future it is considered its realization.

During the visits, the need for plant replacement, the need for irrigation for the establishment of newly planted plants is studied and a baseline of insects and avifauna has been established.

14. We are especially interested in the cooling benefits of your work. He mentioned anecdotal evidence about a 2-degree reduction in ambient temperature as a result of the project. How has it been achieved and measured? Are there other initiatives in Medellín that can contribute to the cooling effect? For example, cold surfaces and rooftops? Does the city have a future plan to cope with rising temperatures?

The reduction of temperature by shade of arborization and control of albedo with vegetal surfaces, in public space of the tropics is not anecdotal, it is real, due to the thermal exchanges that occur between the direct solar phenomenon, the accumulation of heat on stone surfaces and its reflectivity, added to the interaction with the air directly in contact with these surfaces. This condition of radiation and surfaces generates the phenomenon of heat island, which in the case of the centre of Medellín is estimated as +6° above the average temperatures by natural geographical conditions, that is, temperature ranges that oscillate between 24°C and 38°C.

The effect of urban shade and vegetation cover has presented a punctual decrease in surface temperatures and thermal sensation that oscillates between 2°C and 3°C on interventions where vegetation has been consolidated and improved the performance of existing trees, while progressively growing new individuals. The bioclimatic design of these corridors has computer-simulated radiation analysis models, based on performance studies of about 30 species of trees typical of Medellín's climate. The partial performance of these interventions is verified by means of temperature sensors



and an infrared camera that records radiant surface temperatures. Reference is made to partial performance because the plantings of arborization species are still to develop their heights and maturity cups, so the phenomenon of temperature reduction can increase over time and the consolidation of vegetation.

Figure 6.1, Figure 6.2, Figure 6.3, Figure 6.4 and Figure 6.5 are the thermal images that allow to evidence the temperature differences between shaded areas with areas exposed to radiation, as well as the difference in reflectivity between stone surfaces and natural textures.

There is no general heat island control plan in the city of Medellin that involves buildings beyond some particular green wall and roof initiatives. However, the intervention on parks and green corridors is promoted as a pioneering intervention in the environmental challenge of improving urban habitability by reducing the heat island, along with sustainable mobility strategies such as electric public transport vehicles to improve air quality.

Could you explain in greater detail how this project joins with broader sustainability efforts in Medellin?

From the environmental point of view, the project has a very important component, since it improves air quality, as there is an increase in carbon capture, retention of particulate matter, improvement of the landscape, among others, which leads to greater comfort of users in public space, in the future it is expected to obtain the reduction of air conditioning systems along the road corridors, as a result of the decrease in temperature.

Another benefit that is obtained is the improvement in citizen behavior by presenting greater comfort and habitability in public space. Likewise, a social benefit is generated by the generation of employment that the project generates over time, this is important since it is aimed at people of low economic level, representing for these people a substantial improvement in their quality of life.

At the economic level, the project is involved within the plant material production chain, which encourages the demand for products and inputs for the maintenance and maintenance of the Green Corridors.

Could you tell us about other benefits not related to cooling, such as improving air quality, increasing biodiversity, improving pedestrian pathways, quality of life, etc.? What evidence do you have on these aspects? How do you currently quantify the environmental services provided by these corridors?

There are a variety of ecosystem services that green corridors can provide. Understanding that ecosystem services are defined as the conditions and processes by which ecosystems, and the species that inhabit them, maintain human life. These are classified into 4 broad categories: support, provision, cultural and regulatory.

Among the services provided by a green corridor are considered:

- **Support services:** provision of habitat for species and maintenance of biodiversity, nutrient cycling (feeding for some species)



- **Regulation service:** climate regulation (see answer question 7), air quality regulation.
- **Cultural services:** understood as the non-material benefits obtained from ecosystems through spiritual enrichment, physical beauty, artistic and intellectual inspiration, cognitive development, reflection, creation and aesthetic experiences.

15. How is the project maintained? He mentioned hiring specialized gardeners. How will you ensure that vegetation survives and thrives for the future?

To achieve the maintenance of the project, it has been linked to the Botanical Garden of Medellín – Joaquín Antonio Uribe, which actively participates in the process of landscape beautification of different public spaces of the city; formed by an interdisciplinary team that combines the experience of biologists, forestry engineers, environmental engineers, landscape architects and agronomists, accompanied by gardeners and experienced operators, competent to carry out an integral management of the landscape and floristic component of the proposals related to public space. This accompaniment has been carried out since 2011. The result of this is the good condition of the sites intervened so far.

This type of contracting has allowed the Botanical Garden of Medellín to be custodian of the gardens, vegetable covers, epiphytic plants, trees, shrubs and palms, the maintenance and improvement of the quality of the established is guaranteed, involving in turn an increase in floristic diversity in the city.

The experience of the Botanical Garden of Medellín allows to have little by little a global and experienced knowledge of the vegetation, ensuring that the plant component is intervened in an appropriate way, being participants in the planning policies of the arborization in the region.

In addition, a social accompaniment is carried out, in which a work of appropriation and awareness is constantly being done that seeks that the community understands its fundamental role in the sustainability of the Corridors.

For this we work from 4 approaches:

- **Appropriation and social mobilization:** Encourage citizen appropriation of spaces of community interrelation, strengthening collective leadership through communicational work between the community and institutions, promoting the good use, care and appropriation of public space.
- **Participation information:** Through social accompaniment it is intended to promote citizen participation through the exercise of surveillance and community control for the proper development of the work, channeling concerns, doubts, annoyances and proposals of the population to make them participate in the solution.
- **Dissemination:** Disseminate the project for citizens, in order to strengthen its projection, as a replicable model of intervention, recognition and assessment of its objective.



- **Citizen training and training:** Educate the community through training and practical playful education about the importance of their participation in the care and protection of the works
- **Transversal activities:** Interact with the different public and private entities for social participation, support and valuation of the Green Corridors project through educational, cultural and artistic activities that promote environmental development in the city.

Expert (specialized) gardeners come from all over the city, at the moment the botanical garden of Medellín has around 300 gardeners doing forestry activities in the green areas of all the communes of Medellín. Many of them are from rural areas, peasants, coffee pickers and for different circumstances migrated to the city. Some of the gardeners have the labor certification of the SENA where they accredit being gardeners with technical criteria and at all times they are being trained in the field and feedbacks in the knowledge of gardening.

Although you cannot ensure 100% that the vegetation survives, you can have the peace of mind that the species sown were previously selected according to their adaptability to the conditions of the city, also hiring specialized gardeners guarantees the treatment that should be given to the plants in terms of pruning, phytosanitary control, fertilization, control of arvenses, irrigation among others. Additionally, periodic visits are made throughout all corridors to identify needs for replanting or restitution of plants, trees, shrubs, palms and soil, and suggest practices for their correction.

16. **Can you tell us more about how you have involved the community in the design/implementation of this initiative? In particular, how have you engaged poorer neighborhoods to ensure that benefits are distributed equitably?**

At the time of execution, the contractor is the one who can receive the resumes of the people who are interested in intervening in the execution of the project. Prior to the start of the work, socializations are carried out so that anyone who wishes to participate in the execution applies.

The operator botanical garden of Medellín "Joaquín Antonio Uribe", has some methods and procedures for the selection of personnel, which can be accessed by people of low economic level.

17. **He mentioned that the project is 100% funded by the government. What role does the ACI play in attracting private funding to this project?**

The Agency for Cooperation and Investment of Medellín and the Metropolitan Area – ACI Medellín is an association of public entities: Alcaldía de Medellín, EPM, Área Metropolitana del Valle de Aburrá and EMVARIAS.

Since its creation in 2002, it has established itself as a key player in the internationalization process for the development of the territory through the construction of strategic international relations, facilitating access to the city and the region of international cooperation resources and the arrival of national and foreign investment.

On its cooperation management front, it is responsible for seeking technical or financial resources to leverage the programs prioritized by the City Government Plan, by applying



these good practices to calls for cooperation among which are: subsidies, awards, management in international networks of cities, etc.

Similarly, Medellín has understood that it is necessary not only to demand cooperation, but it is important to offer cooperation, in this case technical, so we constantly receive the visit of delegations of local and international governments interested in knowing the good practices and lessons learned in different topics, in this case the Green Corridors project is an experience that we are currently making visible before the eyes of the world for its direct impact on the social, urban and environmental development of Medellín.

18. Do you plan to further expand green spaces in the city? And if so, in what way, and how will they be financed?

The present administration invested resources for the greening of the city through this project and others; and it is proposed that this project and others related to the improvement of air quality be a Public Policy, which implies that there is a budget in each administration for its execution and maintenance, since due to the particular conditions of Medellín, in which there are two periods a year where critical levels of pollution are presented, these actions must continue to be carried out with the aim of contributing to the improvement of air quality and as a consequence to the improvement of the health of citizens.

Medellin's Awards

In 2009 Medellín won the Curry Stone Design Prize — an annual award for innovative excellence in humanitarian design.

In 2012 the Urban Land Institute, an international nonprofit, named Medellín "Innovative City of the Year."

In 2016 Medellín was awarded the Lee Kuan Yew World City Prize, named after Singapore's first prime minister, for its sustainable urban design.

Green Corridors initiative has won the:

- 2019 Ashden Award for Cooling by Nature.
- 2019 C40 Cities Bloomberg Philanthropies Award.

